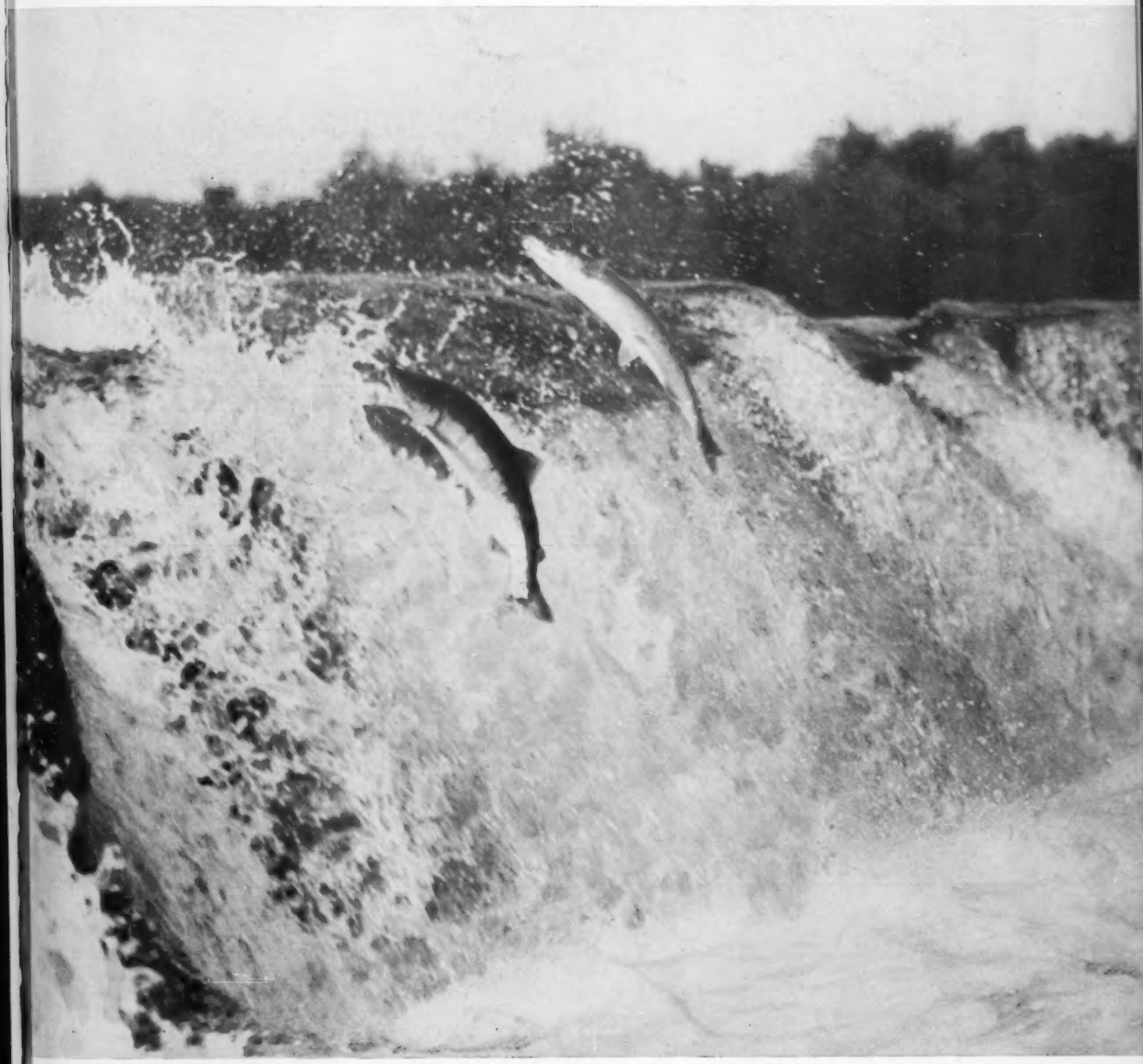
NATIONAL ACADEMY OF SCIENCES
LIBRARY
SEP 23 1960
NATIONAL RESEARCH COUNCIL

SCIENCE

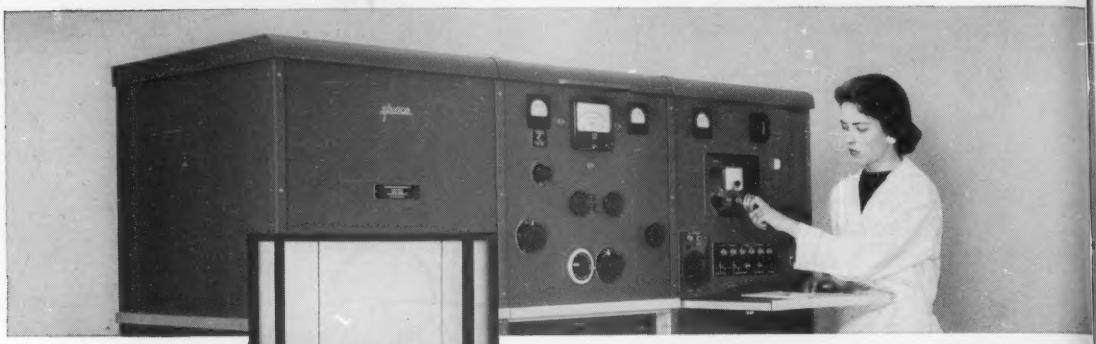
23 September 1960
Vol. 131, No. 3430

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

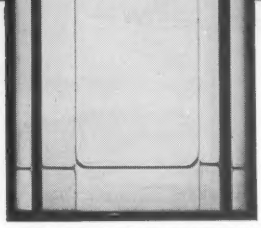


New Methods Extend the Usefulness of the Ultracentrifuge

Recent studies by research scientists have further increased the uses of the Analytical Ultracentrifuge for measuring molecular weights and purity of viruses, enzymes, proteins, polymers and a variety of organic and inorganic molecules. Here are four new developments as reported in the technical literature.



Interacting Systems

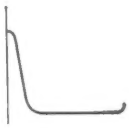


Kegeles and Rao at Clark University have measured the molecular weights of chemically reacting systems in the ultracentrifuge cell using the Archibald "approach-to-equilibrium" method. Studying the enzyme system alpha-chymotrypsin, they showed it to be present in the ultracentrifuge cell as an equilibrium mixture of monomers, dimers, and trimers. This is an extension of previous work which showed that the Archibald method applies to polydisperse non-ideal solutions, as well as to monodisperse ideal solutions.

Improved Accuracy

Trautman, at New York's Rockefeller Institute for Medical Research, showed that the accuracy of the Archibald method can be improved by more precisely locating the position of the meniscus on the ultracentrifuge photographic plate. He made a detailed study of the optical fine structure at the meniscus, and used a special optical aligning procedure with a mirror in the ultracentrifuge cell.

Simplified Measurements



At Stockholm's Nobel Medical Institute, Ehrenberg reports a simplified approach-to-equilibrium method which makes measurements from the schlieren curve easier. He runs the ultracentrifuge fast enough for a peak to begin forming at the meniscus so that the schlieren curve is parallel with the baseline and no extrapolation is necessary. His measurements of molecular weight and diffusion constants agree closely with those by other methods.

Rapid Equilibrium

Van Holde and Baldwin at the University of Wisconsin have used short liquid columns to achieve complete sedimentation equilibrium in a fraction of the time previously required. Using liquid columns of only 3 mm, they report equilibrium with sucrose in 3½ hours, and with a 1 mm column in only 30 minutes. In addition, the authors report that measurements during approach-to-equilibrium permit calculation of a diffusion coefficient.

If you are not familiar with the Ultracentrifuge, we will be happy to send you copies of "An Introduction to Ultracentrifuge Techniques" and the latest issue of "Fractions", a periodical sent to owners of Spinco ultracentrifuges, electrophoresis-diffusion instruments and amino acid analyzers. Write Spinco Division, Beckman Instruments, Inc., Stanford Industrial Park, Palo Alto 5, California.

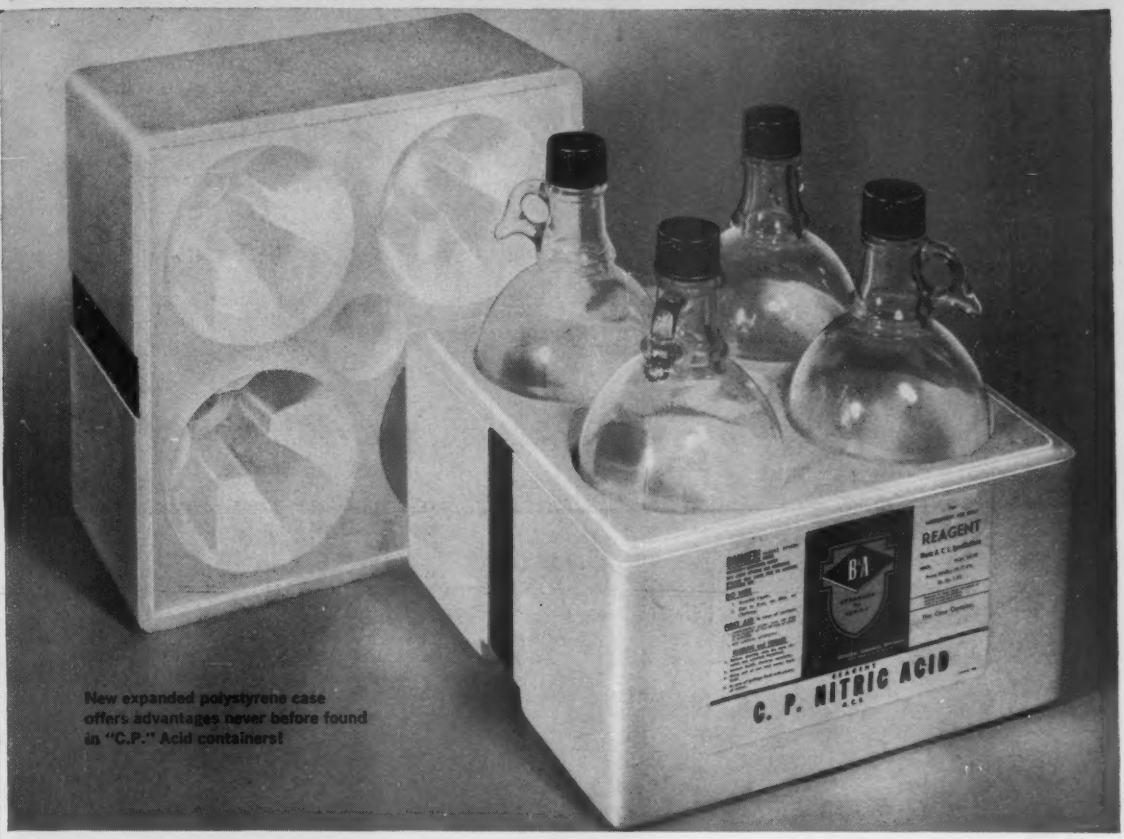
Sales and service facilities are maintained by Beckman/International Division in fifty countries

INSTRUMENTAL IN YOUR FUTURE 25 YEARS 1935-1960

Beckman® / **Spinco Division**
Beckman Instruments, Inc.

8-60A

TOTALLY NEW!



New expanded polystyrene case offers advantages never before found in "C.P." Acid containers!

Lighter! Stronger! Safer! Exclusive new expanded polystyrene case for B&A® "C. P." Acids!

An exclusive development of General Chemical, this new "one-way" case holds four 5-pint "C.P." acid bottles in contoured pockets formed of shock-resistant low density expanded polystyrene. Here is still another packaging "break-through" from America's leading producer of laboratory and scientific chemicals . . . another example of continuing B&A leadership in reagent packaging.

Smaller! Lighter! The new case is substantially smaller than old-fashioned containers and is far easier to store and handle. Tare weight with empty bottles is less than 11 pounds. This saves you money on freight.

Easier to handle! Convenient finger grips make case easy to lift and carry. Top and bottom specially designed with interlocking feature for safe stacking.

Safer! The new polystyrene case is chemically resistant, and it is weather-resistant, too. Withstands outdoor storage. Bottles are "cradle cushioned," fully protected in form-fitted polystyrene pockets.

Stronger! The new case is far stronger than other "one-way" cases now in use for "C.P." acids. In thorough and extensive testing, it has met the most stringent ICC drop test requirements . . . bottles remained unharmed after 16 separate drops from a 4-foot height!

Order Now! These new units are now ready for shipment from General Chemical's B&A distributing points coast to coast. They have had more than a year of intensive research and testing and are *proved* superior to any other type of "shipper" now available! For further information, phone or write your nearest B&A office.

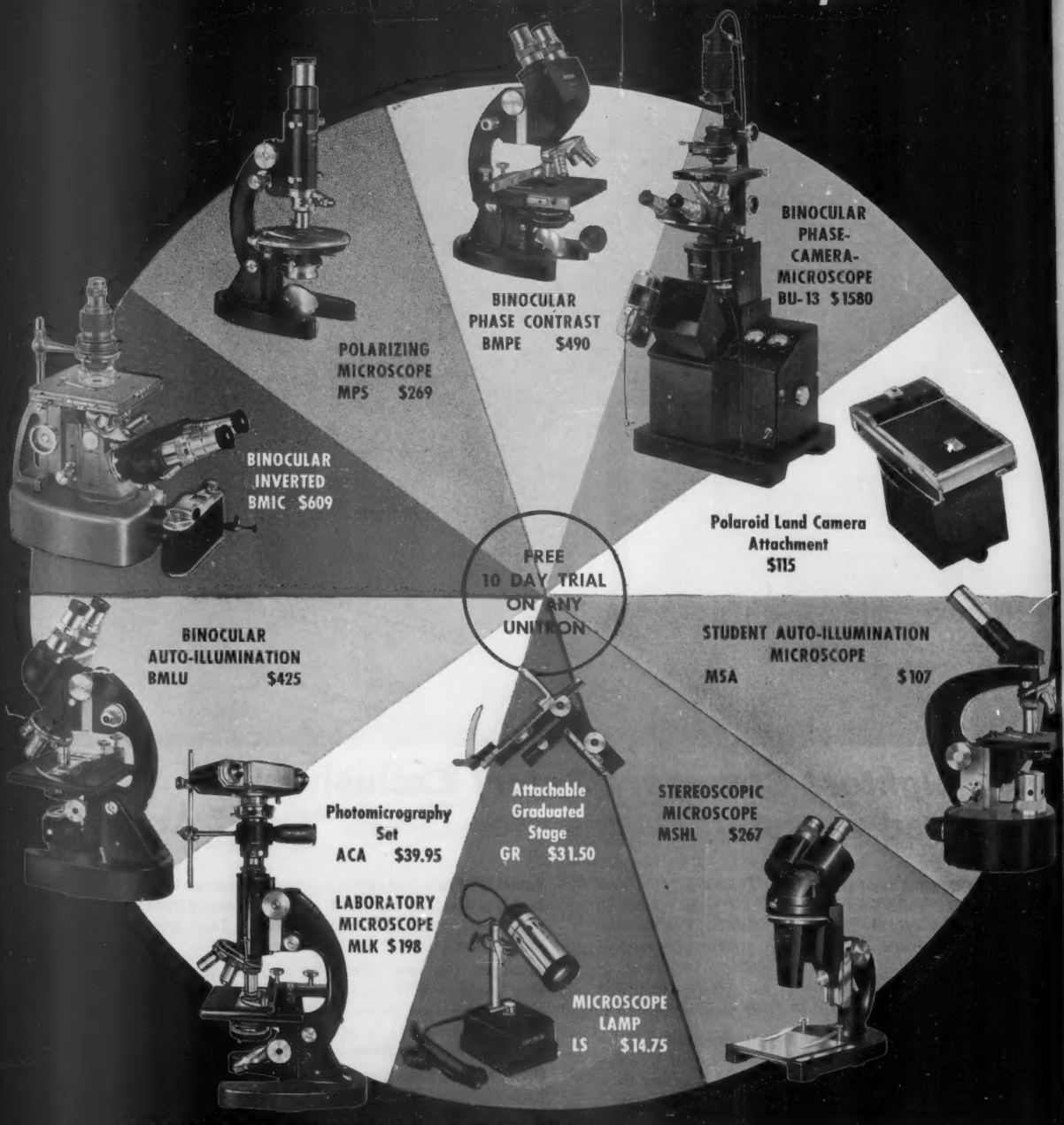
BAKER & ADAMSON®
"C. P." Acids

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N.Y.

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Second-class postage paid at Washington, D.C., and additional mailing office. Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢.

In the Laboratory . . . where optical quality counts . . . the trend is to UNITRON Microscopes


BINOCULAR PHASE CONTRAST BMPE $490
BINOCULAR PHASE-CAMERA-MICROSCOPE BU-13 $1580
POLARIZING MICROSCOPE MPS $269
BINOCULAR INVERTED BMIC $609
Polaroid Land Camera Attachment $115
FREE 10 DAY TRIAL ON ANY UNITRON
BINOCULAR AUTO-ILLUMINATION BMLU $425
STUDENT AUTO-ILLUMINATION MICROSCOPE MSA $107
Photomicrography Set ACA $39.95
Attachable Graduated Stage GR $31.50
STEREOSCOPIC MICROSCOPE MSHL $267
LABORATORY MICROSCOPE MLK $198
MICROSCOPE LAMP LS $14.75

UNITRON offers an extensive line of Laboratory Microscopes & Accessories for Research, Industry and Education. Illustrated is a partial selection for biology, medicine, chemistry and related fields. UNITRON also has companion instruments for the metalworking industries.

Noted for optical quality . . . advanced optical and mechanical design . . . unique and convenient operational features . . . long wearing construction . . . attractive budget prices which include basic optics . . . these, together with years of proven instrument performance, are the reasons why . . .

THE TREND IS TO UNITRON!

UNITRON

INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO.
204-206 MILK STREET • BOSTON 9, MASSACHUSETTS

Please rush UNITRON's Microscope Catalog 4G-4

Name_____

Company_____

Address_____

City_____ State_____

23 September 1960, Volume 132, Number 3430

SCIENCE

Editorial Win the Argument and Lose the Debate 783

Articles Guideposts of Migrating Fishes: *A. D. Hasler* 785
New findings have added to our knowledge of how fish use olfactory and visual cues to find their way home.

Birds, Bees, and Ballistic Beasts: *B. G. Holzman* 793
Air Force basic research in biology may provide clues for improving missile detection and computers.

Science in the News Disarmament: A New Agency Is Organized To Coordinate Research and Planning of Policy 795

Book Reviews A. L. Takhtajian's *Die Evolution der Angiospermen, Origins of Angiospermous Plants,* and *Essays on the Evolutionary Morphology of Plants,* reviewed by *L. Constance;* other reviews 801

Reports Relationship between Feeding and Satiation Centers of the Hypothalamus: *W. Wyrwicka* and *C. Dobrzecka* 805

Stimulation of Postirradiation Recovery of Cells by Cutting: *A. C. Giese* and *M. Lusignan* 806

Verification of Earth's "Pear Shape" Gravitational Harmonic: *C. J. Cohen* and *R. J. Anderle* 807

Temperate Pollen Genera in the Eocene (Claiborne) Flora, Alabama: *J. Gray* 808

Isotopic and Zoogeographic Paleotemperatures of Californian Pleistocene Mollusca: *J. W. Valentine* and *R. F. Meade* 810

Departments Forthcoming Events; New Products 812

Letters from *G. F. Roll; J. P. Hailman* and *J. B. Best; G. E. Gates* and *A. B. Grobman; C. W. Crannell; S. E. Ross; H. Milgrom; F. W. Morthland; F. Hoelzel; J. Helwig; W. T. Powers, C. E. Wells, H. G. Wolff; W. H. Allen, H. R. Dursch, R. R. Newell; B. T. Scheer* and *J. T. Enright* 828

Cover Salmon ascending Brooks Falls, Alaska, en route to their home stream to spawn. See page 785. [George B. Kelez, U.S. Fish and Wildlife Service]

TESLA ELECTRON MICROSCOPE—Desk Model BS 243

Guaranteed Local Service

Installation and Instruction Included in Price

TESLA

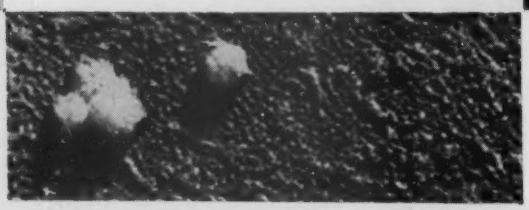
The Little Giant

60 kV
30,000X
30Å

TESLA

FEATURES

- Resolving power 30Å to 50Å in routine operation, optimal resolution 25Å
- Magnification 1,000X to 30,000X, adjustable in steps
- Accelerating voltage 60 kV ±0.01%
- High-voltage stability better than 10^{-4}, ripple less than 2.5×10^{-5}
- Specimen inserted under vacuum
- Specimen motion controlled from microscope platform
- Microscope may be tilted for stereo-photography
- Viewing port usable for diffraction patterns
- Uses standard 35 mm film (36 pictures) or ten 2" x 2" plates
- Dimensions of basic instrument: 14½" wide, 18" deep, 34½" high
- Low initial cost and minimal maintenance



Made in Czechoslovakia

Worldwide Distribution by

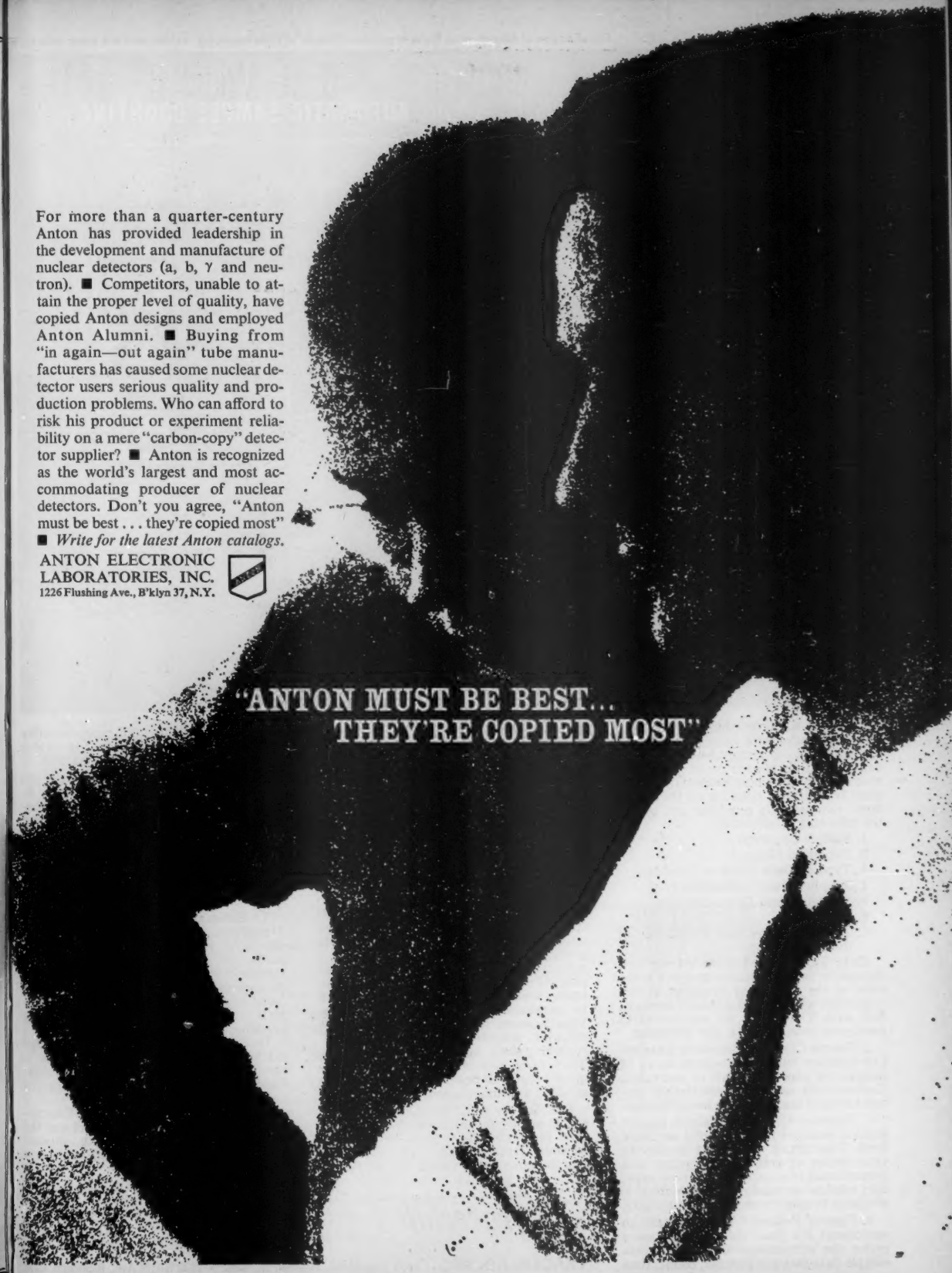
KOVO

For Complete description, technical data, and ordering information, write for BULLETIN 8-2000

EXCLUSIVE SALES AND SERVICE IN U.S.A.

NATIONAL INSTRUMENT LABORATORIES, Inc.

828 Evarts St., N.E., Washington 18, D. C. **Tel.: NOrth 7-7582**



For more than a quarter-century Anton has provided leadership in the development and manufacture of nuclear detectors (a, b, γ and neutron). ■ Competitors, unable to attain the proper level of quality, have copied Anton designs and employed Anton Alumni. ■ Buying from "in again—out again" tube manufacturers has caused some nuclear detector users serious quality and production problems. Who can afford to risk his product or experiment reliability on a mere "carbon-copy" detector supplier? ■ Anton is recognized as the world's largest and most accommodating producer of nuclear detectors. Don't you agree, "Anton must be best . . . they're copied most" ■ *Write for the latest Anton catalogs.*

ANTON ELECTRONIC LABORATORIES, INC.
1226 Flushing Ave., B'klyn 37, N.Y.

One of a series of discussions on topics of particular interest to those employing radioisotopes and tracer techniques.

Let's Talk About AUTOMATIC SAMPLE COUNTING . . .

by Wendell C. Peacock, Vice President and Technical Director, Tracerlab, Inc.

There is nothing complicated about selecting automatic sample counting equipment . . . It simply boils down to a careful analysis of your needs. When you reach the point where automatic equipment is desirable, consider all the equipment commercially available and obtain the following information:

1. Sample Capacity
2. Detection Method
3. Type of Data Printout Provided
4. Simplicity and Versatility
5. Efficiency and Reproducibility
6. Cost
7. The Experience and Reputation of the Manufacturer

Since TRACERLAB introduced the first automatic sample counter and has made most of the significant advances in this important area, it seems logical to check first with TRACERLAB for equipment to meet your requirements. For example:

1. *Sample Capacity?* Standard TRACERLAB counters will accommodate up to 50 samples on planchets, vials or test tubes. Custom-built units accommodating several hundred samples have been supplied.

2. *Detection Method?* For alpha, beta or gamma emitters in either solid or liquid form, TRACERLAB equipment employing your choice of scintillation, geiger and proportional (conventional or flow type, thin window or windowless) detectors, is available to count samples automatically.

3. *Type of Printout?* With TRACERLAB equipment it's your choice. Most users prefer the convenience of the complete sample data (sample number, count, time and count rate) provided by TRACERLAB's Auto/Computer and Auto/Printer. Records are always *complete* and an overriding preset-time, preset-count feature permits frequent insertion of background samples without excessive time delays. However, if the economy of a printing timer is desired, this is also available. And remember, whether you wish to use commercial tape punch or card punch machines, TRACERLAB systems will function smoothly and effectively with almost any system you choose.

4. *Simplicity and Versatility?* All TRACERLAB automatic sample counting systems employ the same scalers and data printers. Therefore, when you need a second automatic sample changer, a stepping chromatogram, a stepping spectrometer or manual equipment, there's no need to purchase duplicate instrumentation. What's more, you won't find any huge complex consoles with *"intergalactal"* control panels in TRACERLAB systems. They have a minimum of controls, require very little bench space, and can be serviced and maintained with ease.

5. *Efficiency and Reproducibility?* Vital points in any technical comparison. The need for high efficiency is obvious but without reproducibility an automatic sample counting system is worthless. Ask about efficiency and reproducibility and remember that TRACERLAB makes every effort to optimize both features.

6. *Cost?* Don't be misled when you price an automatic system. Be sure to include *all* of the components and accessories required for a complete functioning unit; you'll be surprised at the relatively low cost of a TRACERLAB system. The cost will be even less if you already own a Tracermatic scaler because all scalers in TRACERLAB's new line have built-in automatic capabilities.

7. *Experience and Reputation of the Manufacturer?* Remember these facts and decide for yourself. TRACERLAB not only made the first commercial automatic sample counting system, but is today the *only* company which designs and manufactures not just one or two, but a complete line of automatic sample counting systems.

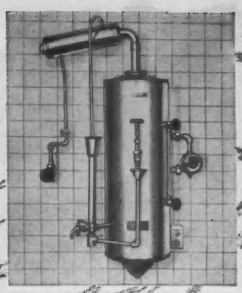
In short, TRACERLAB can provide automatic sample changers and systems to meet your every requirement and, most important of all, you get everything you need from a single source.

For complete information on TRACERLAB's automatic sample changers and the complete line of TRACERLAB nuclear equipment, write for your copy of the new General Catalog F.

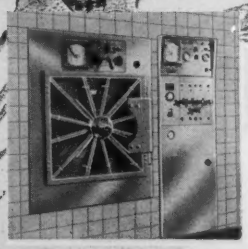
Tracerlab *first in radiation measurement*

Tracerlab KELEKET

TRACERLAB, INC. • 1609 Trapelo Rd., Waltham 59, Mass. • 2030 Wright Ave., Richmond, Calif.



WATER STILLS
Capacities from ¼ to 500 gal./hr.
Steam, Electric or Gas Heat.



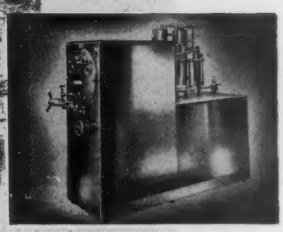
STERILIZERS
Pressure Steam, Gas-Steam,
and Gas. Chambers 16″ x 16″ x 24″
to 60″ x 66″ x 120″.

TALK MICROBIOLOGICAL EQUIPMENT···

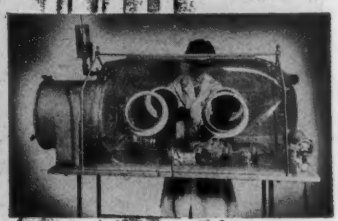
and you have to talk to American Sterilizer!

● Here at Amsco, sterilization is still of prime concern. However, to parallel the great strides of modern biological technology, we've developed a number of highly specialized microbiological devices—all designed to do their job better with less personnel time and attention and at a cost well within practical limits.

If you've a problem in this area, a letter to our Scientific and Industrial Department may lead to its economical resolution.



BIOGEN • *continuous culture apparatus*
For batch or continuous culture of pure microorganisms in controlled conditions.



DRY BOX
Flexible film chamber.
Efficient, economical,
easy to work with.

FREEZE DRY APPARATUS
Laboratory, pilot plant and production models. Used for the preservation and concentration of labile substances.

GERM FREE LIFE APPARATUS
Complete service, including flexible operating, rearing and transfer chamber.

SCIENTIFIC AND INDUSTRIAL DEPARTMENT

AMERICAN STERILIZER
ERIE • PENNSYLVANIA

World's largest designer and manufacturer of Sterilizers, Operating Tables, Lights and related biological equipment

REQUIRES NO LUBRICATION

NEW QUICKSEAL FREEZE-DRYING FLASKS

- Maintain the same high vacuum, without grease, as standard flasks using lubricated ground glass surfaces.
- Eliminate the possibility of grease contaminating valuable samples.
- The bottom and top sections of Quickseal Freeze-drying Flasks have a smoothly beveled edge which slip fits into a double faced silicone rubber gasket. Entire set-up time is less than 10 seconds — less time than it takes to grease a standard ground glass flange.
- Lack of toxicity for sensitive biologicals plus excellent chemical and thermal stability are built-in qualities of silicone rubber.
- The cushioning effect of the soft rubber gasket appreciably reduces flask breakage.
- Quickseal Freeze-drying Flasks are available in volume capacities from 25 ml to 1,000 ml with either 19/38 or 24/40 top joint.

For full details and name of nearest distributor, write:

THE VIRTIS COMPANY, INC., GARDINER, NEW YORK

Recommended by Public Health Authorities, for

FLUORESCENT ANTIBODY TECHNIQUE . . . .

"FLUOREX"

BY

REICHERT

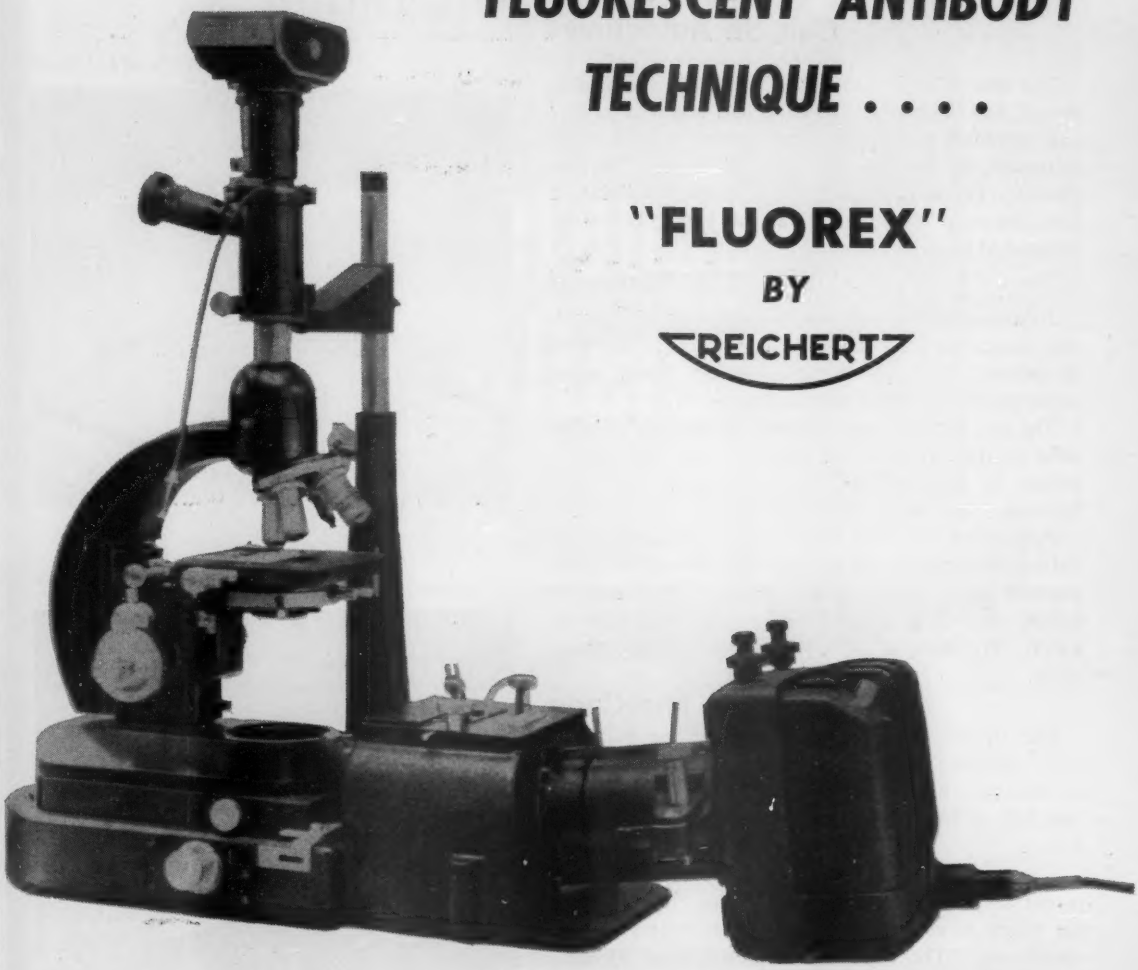


Photo shows "FLUOREX" with "BIOZET" microscope and photomicrographic components

For your safety the "Fluorex" has a completely enclosed light path. In mere seconds your microscope is aligned to the "Fluorex" and stays in rigid position. A surface deflection mirror permits convenient centering of the light source—a 200 Watt Osram Mercury Vapor Burner.

Also available with DUAL lamp for instantaneous transition from routine to fluorescent illumination.

Write for catalog or request demonstration.

WILLIAM J. HACKER & CO., INC.

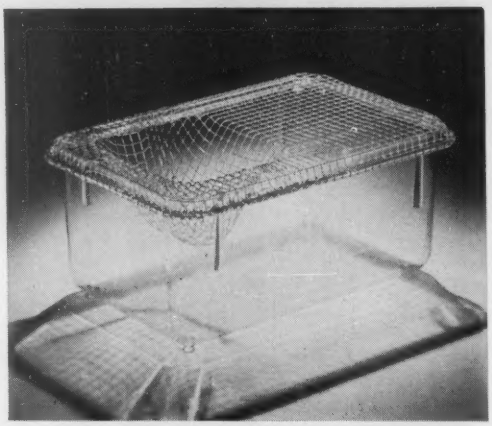
P. O. Box 646 West Caldwell, New Jersey

Another Econo-Cage First! Unbreakable Clear Cages Can Be Autoclaved

econo-cage

The new ECONO-CAGE #27 is clear, can be autoclaved, and cannot be broken. This remarkable new unit combines the optical and thermal properties of glass with the strength properties of the new thermoplastics. Econo-Cage #27 affords perfect visibility, a heat distortion point of 280°F., and impact resistance unmatched by any other clear material.

Econo-Cage #27 with Lid #22D



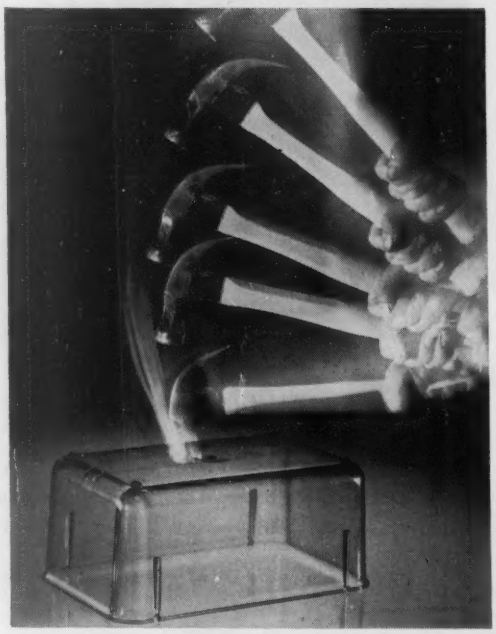
The Material

Extensive testing of new plastic materials reveals that polycarbonate resin (a linear aromatic polyester of carbonic acid) has properties ideally suited to the requirements of animal care and research.

The material has very high impact strength. Unlike most plastics, it does not shatter under high energy impact by sharp objects, such as bullets. Thin wall sections do not break after repeated hammer blows.

Polycarbonates retain tensile strength and impact resistance from well above boiling down to —40°C. The material has a very low absorption level, increasing in weight only 0.3% after 24 hour total immersion in water. The material does not absorb odor producing gases.

Impact testing Econo-Cage #27



The Cage

The overall dimensions of Econo-Cage #27 are 11½″ by 7½″ by 5″ deep. It is one of "#20 series" Econo-Cages designed primarily for mice. The cage uses lids #22A, #22B, #22C, and #22D (see pages 8-9).

The cage sides have a 3° draft and four side ribs to permit easy stacking and nesting. The ribs also permit steam to circulate inside of nested cages during autoclaving. The cage bottom is supported by four feet.

Polycarbonate Econo-Cage #27 will undergo repeated sterilizing at 250°F. for fifteen minutes without distortion. The cage has excellent resistance to most acids and fair resistance to basics.

Distributors

The complete Econo-Cage line is available exclusively through the following distributors:

ALOE SCIENTIFIC
BRAUN-KNECHT-HEIMANN CO.
W. H. CURTIN & CO.
FISHER SCIENTIFIC
E. H. SARGENT & CO.
SCENTIFIC PRODUCTS
ARTHUR H. THOMAS CO.
THE WILL CORPORATION

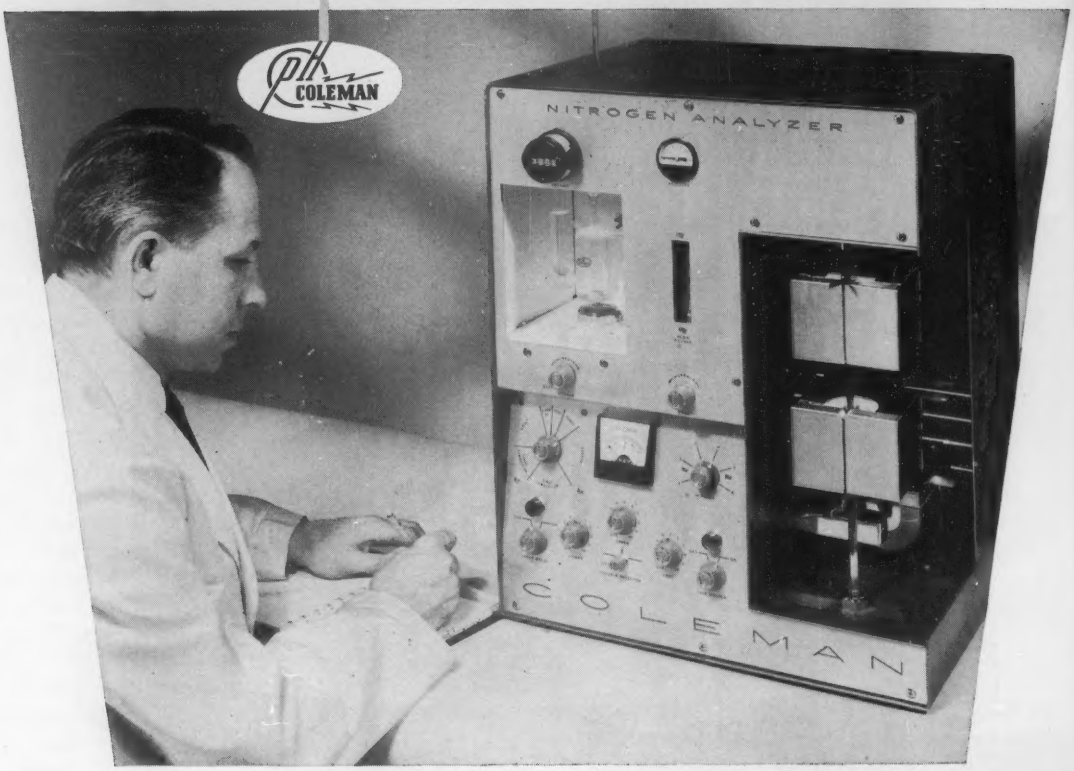
Maryland Plastics, Inc. **Econo-Cage Division** **Federalsburg, Maryland**

Ultraviolet and visible wavelengths.
Finest optical performance available.
Standard sizes 1″ x 1″ and 2″ x 2″ —
other sizes and shapes on special order.
Write for brochure X-22.

BA

BAIRD-ATOMIC, INC.
33 university road · cambridge 38, mass.

COLEMAN



Coleman automation of Dumas method speeds nitrogen determinations

Automating each operation in the Dumas procedure, the Coleman Model 29 Nitrogen Analyzer adapts the time-proven method to rapid, exact analysis of an almost unlimited range of materials. Highly successful tests have been made on experimental substances as well as on routine materials.

In addition, many substances formerly analyzed by the Kjeldahl method have yielded to Coleman-instrumented analysis with thoroughly satisfactory results — tobacco, leather products, plastic resins, cereals, dog food, fabrics and fertilizers.

Combustion times, temperatures and flow rates—all manipulations required in the Dumas procedure—are precisely programmed into the instrument, allowing it to accommodate almost any material dissociable at temperatures under 1100° C. Programming makes analysis simple and straightforward . . . operator technique is eliminated as a source of analytical variability.

The instrument determines nitrogen in substances containing from as little as 0.01% nitrogen to more than 75%. At the 10% level, it achieves an accuracy of better than ±0.15%.

A complete determination takes only eight minutes from sample input to final readout on the digital counter . . . there's no need to wait several hours to get the answer you need right now.

Write for Bulletin B-258

Order and simplification are the first steps toward mastery of any science

COLEMAN INSTRUMENTS, INC., MAYWOOD, ILLINOIS

The Cooke M15 . . . a laboratory microscope with superior optical performance. Its clean design and precision construction offer unequalled convenience, versatility and durability.

Manufactured at York in England . . .

specifications on all models available on request . . .

Model M15BY, illustrated above, 30X to 1000X, F. O. B. Boston, $429.

COOKE TROUGHTON & SIMMS, INCORPORATED

91 WAITE STREET, MALDEN 48, MASSACHUSETTS • IN CANADA: 77 GRENVILLE STREET, TORONTO

The range of Whatman products now includes a number of important cellulose derivatives with ion exchange properties, developed for analytical and preparative work in organic, inorganic, and biochemistry.

Whatman CELLULOSE ION EXCHANGERS

TYPE – Four functional ion exchange groups.

P – Cellulose Phosphate CM – Carboxymethyl Cellulose	Cation Exchanger
AE – Aminoethyl Cellulose DE – Diethylaminoethyl Cellulose	Anion Exchanger

PHYSICAL FORM – Versatile application as all four products are available in Floc, Powder, and Paper form.

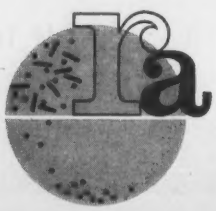
Floc – A course, low mesh fiber used primarily for batch processes or for specific column applications.

Powder – A selected mesh form of the material which will pack homogeneously into a chromatographic column and with a reproducible flow rate.

Paper – Papers are made from the chemically modified fibres. Ion exchange separations with the visual advantages of paper chromatography. Provides a system evaluation before column application.

AVAILABILITY – Through your regular laboratory supply dealer. *Request Technical Bulletin 1031 for price and order information.*

See these on display at
NIH INSTRUMENT EXHIBIT
Booth #105
October 4-7



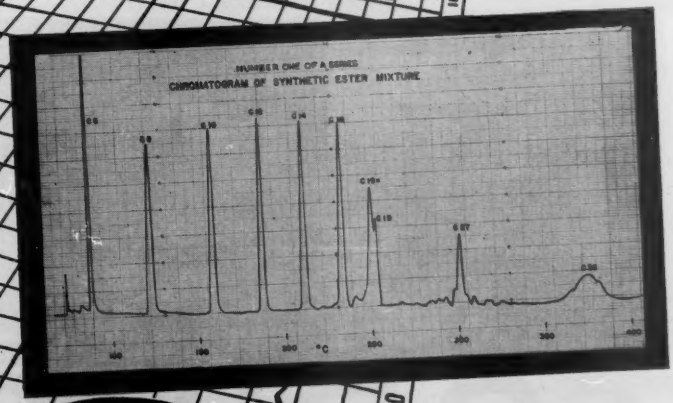
reeve angel
9 BRIDEWELL PLACE, CLIFTON, N. J.

WRITE FOR 10 page preprint describing the Model 500 and a descriptive brochure "Selecting Your Chromatograph", which summarizes F&M's five chromatographic instruments.

LINEAR PROGRAMMED HIGH TEMPERATURE

GAS CHROMATOGRAPH MODEL 500

FEATURING
- Independent operation to 500° C—column, detector, and injection port.
- 18 linear heating rates.
- Circulating air oven for columns to 50 ft.
- Fast-heating, fast-cooling
- 6 min.-change column and re-establish baseline.



F&M

F & M SCIENTIFIC CORPORATION

1202 ARNOLD AVENUE, N.C.C. AIR BASE, NEW CASTLE, DELAWARE—EAST 8-6606

#1 Of A Series

LINEAR-PROGRAMMED TEMPERATURE GAS CHROMATOGRAPHY

I. ANALYSIS OF METHYL ESTERS TO C_{36}

Gas chromatographic analysis of methyl esters of saturated and unsaturated fatty acids to about C_{36} is well-known[*]. Analysis of these materials and higher molecular weight esters in a single run has been limited, however, by suitable instrumentation and the lack of high temperature liquid phases. Analysis of wide boiling esters from C_1 to C_{36} recently was found possible in our laboratory using a linear programmed high temperature gas chromatograph and a silicone gum rubber column.

The chromatogram at the left shows the analysis of a synthetic mixture of saturated C_4, C_8, C_{10}, C_{12}, C_{14}, C_{16} and C_{21} esters, the unsaturated C_{18} oleic acid ester, and the dimethyl ester of C_{36} dimer acid. The run was made on a 2 ft. Chromosorb P—20% silicone gum rubber column using a linear heating rate of 5.6°C./min. over the range of 75° to 400°C. The detector was maintained at 350°C. and the injection port at 400°C. Observe the sharp peaks of nearly the same shape. These are typical of programmed temperature chromatograms as is the even spacing between the members of the homologous series C_8 through C_{14}.

The apparatus used in this work is F & M's Model 500 Linear Programmed High Temperature Gas Chromatograph. In brief, it offers independent operation to 500°C. of the column, hot-wire detector, and injection port. The temperatures of each can be read on a temperature indicator. The unit offers fast-heating, fast-cooling by means of a circulating air oven. The air oven takes column lengths to 50 ft. With column changes, baselines re-establish within six minutes. Additional details were recently described[1,2].

LITERATURE CITED

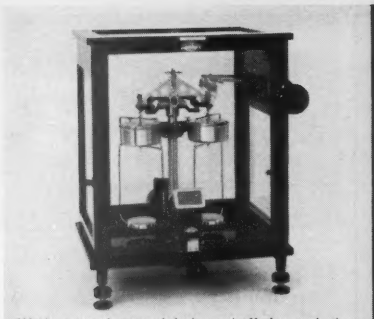
(1.) Anon, *"Gas Chromatograph Hits High °C", Chem. and Eng. News, 38,* 42-43 (1960).

(2.) *Martin, A. J., Bennett, C. E., and Martinez, F. W., Jr., *"Linear Programmed Temperature Gas Chromatography to 500°C"*, presented at the Cleveland ACS Meeting, April 1960.

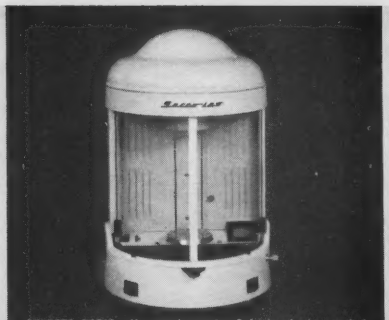
(3.) Orr, C. H., and Callen, J., *Annals N. Y. Acad. Sci., 72,* Art. 13. 559-785 (1959).

• Write **F&M** for free copies.

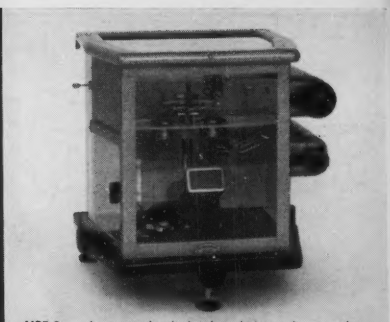
F&M 1202 ARNOLD AVE., N.C.C. AIR BASE NEW CASTLE, DEL. PHONE EA 8-6606



SM-10—a superb research instrument offering semi micro accuracy at a comparatively reasonable price.

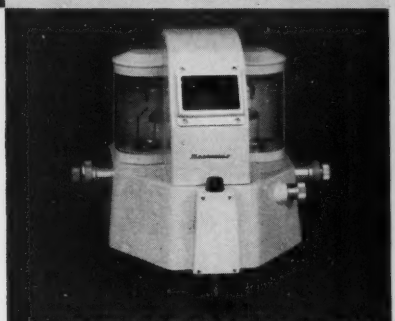


SELECTA RAPID—the most popular Selecta single pan balance for routine analytical procedures.



MPR-5—a two-pan classical micro balance in a modern metal housing incorporating the latest operating features.

THE PRECISE BALANCE FOR THE PRECISE NEED...



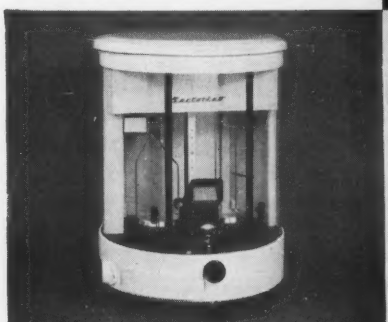
T-11—the speed and simplicity of a torsion balance for samples up to 4 grams with a sensitivity of 0.02 mg.

The increasing use, in every field, of SARTORIUS balances is a natural consequence of their advanced design, unsurpassed craftsmanship in construction and the perfection of their performance.

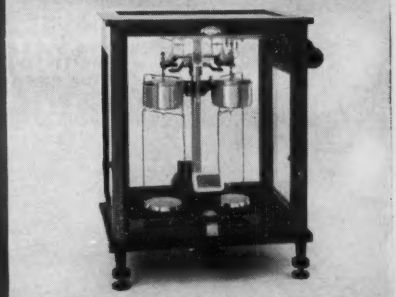
With these intrinsic qualities one who is considering the purchase of precision balances should keep in mind the highly trained service staff maintained by BRINKMANN, at ever ready call, as well as the unconditional service guaranty.

No balance need nor budget requirement has been overlooked by SARTORIUS, the world's largest manufacturer of analytical and other fine balances.

Write for descriptive catalog 442

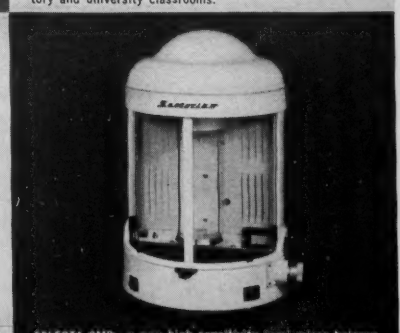


PROJECTA—a truly modern two-pan balance featuring built-in weights, air damping and projection scale.



DP-2—the ideal automatic balance for the smaller laboratory and university classrooms.

KILOMAT—a new series of fully automatic precision balances for gross weighings in plant and laboratory.



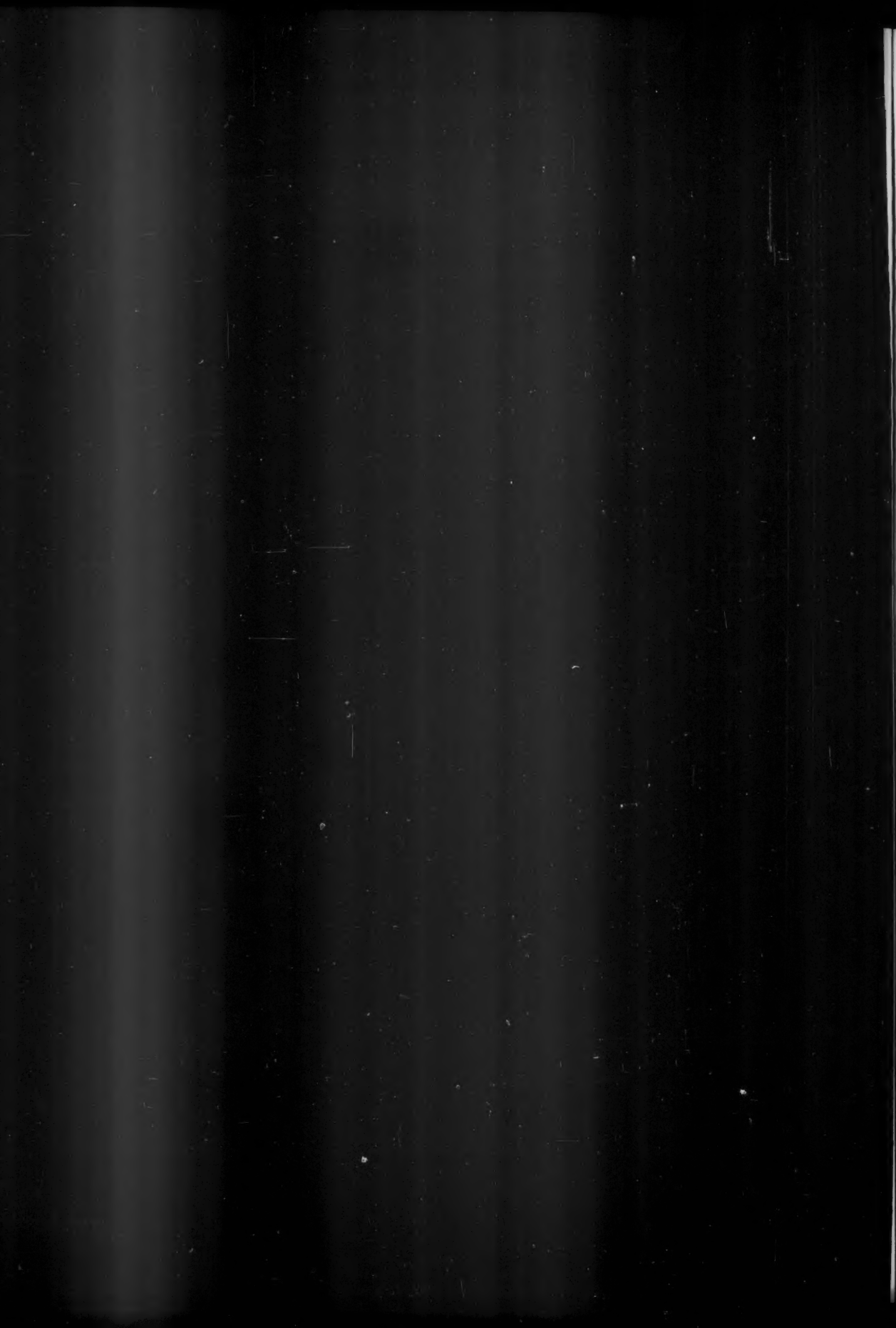
SELECTA SMR—a new high sensitivity semi micro balance which provides faster operation.

SARTORIUS

BRINKMANN INSTRUMENTS, INC., 115 CUTTER MILL ROAD, GREAT NECK, N.Y.

Philadelphia • Cleveland • Houston • Miami • Menlo Park, Cal.

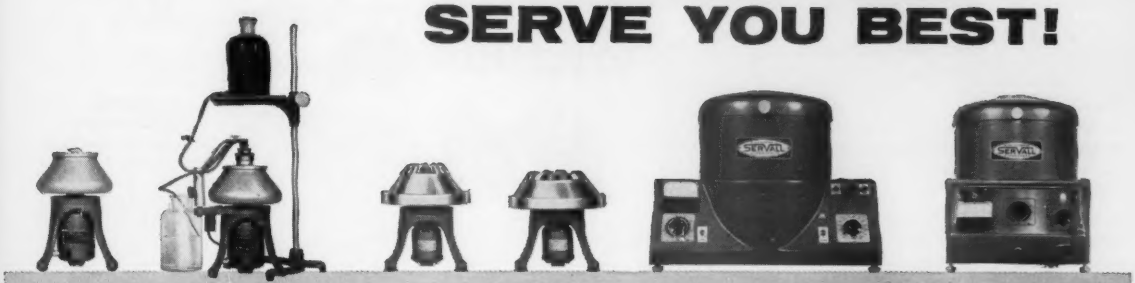
READER SERVICE CARD PAGES
771 AND 772 ARE MISSING.



RIGHT ACROSS THE BOARD

SERVALL®

CENTRIFUGES SERVE YOU BEST!



SS-1 Superspeed — "the workhorse of the modern laboratory" 32,700 x G

SS-1 Superspeed with Continuous Flow System

Small & Medium Centrifuges 5 rotors on one base

SS-3 Automatic Superspeed 17,000 rpm 34,800 x G

SS-4 Enclosed Superspeed — Entire Control Panel snaps out for remote operation

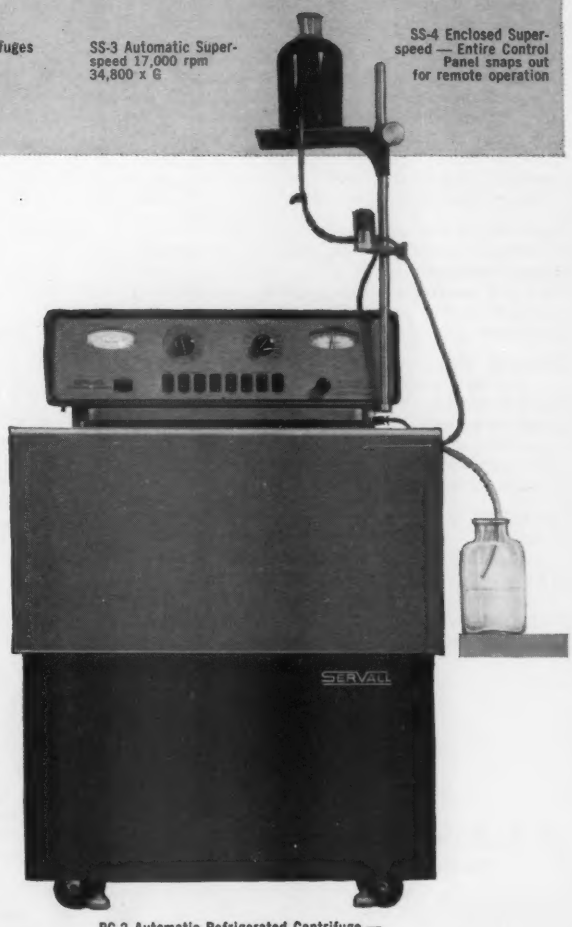
From the SERVALL Small and Medium Centrifuges that offer five different rotors on one basic motor assembly plus a huge variety of tube combinations, to the RC-2, the latest in Refrigerated Centrifugation, SERVALL Centrifuges Serve You Best.

The SERVALL SS-1 Superspeed, SS-3 Automatic Superspeed, SS-4 Enclosed Superspeed and RC-2 Automatic Refrigerated Superspeed Centrifuges, all designed to accept the unique SERVALL 8 to 2 Tube Direct Sedimentation Continuous Flow System, lead the field in a *functional versatility* that is determined by one thing: the modern researcher's requirements—*your* requirements.

Automation, special rotors such as particle counting and field-aligning, high centrifugal force, safety features, operational reliability and simplicity, whichever is *your* major concern SERVALL specifications cover it.

And remember, in the U.S. you get direct, personal service on all your needs from SERVALL-*trained representatives. In Canada and elsewhere* SERVALL *Centrifuges and Instruments are available from specially appointed distributors.*

For that additional centrifuge, or replacement of out-moded or inadequate equipment, do what thousands of others do, select a SERVALL, the centrifuge that has been *proved in operation.*



RC-2 Automatic Refrigerated Centrifuge — basic unit includes standard 8 x 50 ml Superspeed Rotor — up to 37,000 x G

ILLUSTRATED LITERATURE UPON REQUEST FOR CATALOG SC-9GC

Ivan Sorvall, Inc. Norwalk, Connecticut

Analyze for Nitrogen

faster, more accurately

with **'Baker Analyzed'** *Reagents*

The determination of total Nitrogen...Ammonia Nitrogen . . . Protein Bound Nitrogen . . . Nitrate Nitrogen . . . is important in clinical tests and in the analysis and control of plant foods, agricultural products, explosives and munitions.

J. T. Baker offers you a choice of reagents particularly suitable to the needs of your nitrogen determination. Whatever your sample, or the method you elect, one of the 'Baker Analyzed' Reagents described below will help you work rapidly, with greater precision and accuracy.

CHOOSE 'BAKER ANALYZED' SODIUM HYDROXIDE 50% SOLUTION . . . for the neutralization of the acid digestion in the Kjeldahl nitrogen determination. This reagent affords an assay in the range of 50.0-52.0% NaOH . . . the proper concentration for direct addition to the digested sample. No fuss to dissolve, and less chance to "bump" than when adding pellets to the flask.

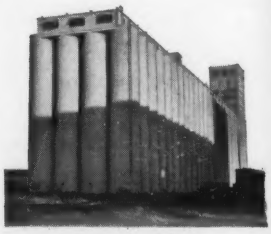
Low blank values are assured by control of Nitrogen Compounds (as N) to 0.0005% maximum. Carbonate (as Na_2CO_3) is held to a level of 0.10% maximum. The polyethylene bottle is convenient and easy to use . . . no chance for breakage. Available in both 1 pt. and 8 pt. sizes.

CHOOSE 'BAKER ANALYZED' POTASSIUM IODIDE . . . for the preparation of Nessler Solution for the colorimetric determination of ammonia. The label shows *actual lot assay* . . . 99.5% or higher ...and the *actual lot analysis* of trace impurities. Nitrogen Compounds (as N) controlled to 0.001% maximum assure low blank values.

ANALYTICAL, RESEARCH AND DEVELOPMENT CHEMISTS . . . you can always depend on 'Baker Analyzed' Reagents for higher defined purity. The *Actual Lot Analysis* appears on *every* 'Baker Analyzed' label. You will find the *Actual Lot Assay* (not merely a range assay) on more than 300 'Baker Analyzed' Reagents.

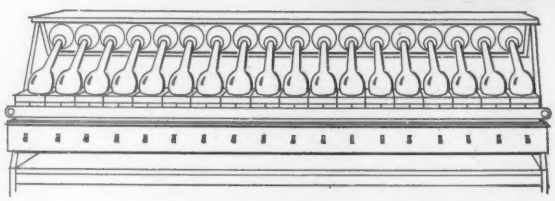
CLINICAL LABORATORIES

Nitrogen is routinely determined for diagnostic purposes. 'Baker Analyzed' Reagents are commended for their suitability in nitrogen determinations in blood, urine, gastric contents and other biological fluids.



AGRICULTURE AND PLANT FOOD INDUSTRIES

Control of nitrogen content is important to the manufacturer of fertilizers. 'Baker Analyzed' Reagents are particularly suitable for nitrogen determinations necessary for the control of plant foods and agricultural products.



YOUR LSR . . . let him help solve your problems of laboratory supply. Your LSR (Laboratory Supply Representative) is an expert. His aim is always to anticipate your needs. His job is to supply you with the equipment, glassware and chemicals you need . . . when you need them. When emergencies arise, call him at once!

J.T.Baker CHEMICALS

J. T. Baker Chemical Co.

Phillipsburg, New Jersey

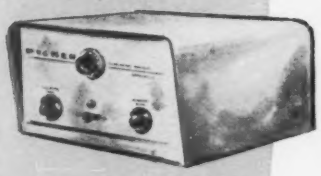
PICKER NUCLEAR

announces a new line of

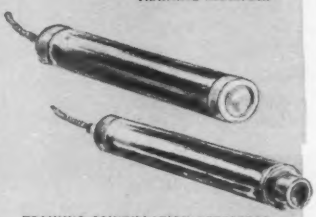
transistorized NUCLEAR TRAINING INSTRUMENTS

TRAINING SCALER

TRAINING RATEMETER



TRAINING ANALYZER



TRAINING SCINTILLATION DETECTORS

TRAINING FLOW COUNTER

PICKER QUALITY AT "BUDGET" OUTLAY

Picker Nuclear announces a comprehensive line of basic instrumentation for training students in radioisotope technics. Uniquely versatile, these instruments permit the scheduling of full laboratory courses in radioisotope technics (including such important fields as pulse height analysis and rate function studies).

The cost of this new equipment falls well within the reach of modest equipment budgets. Instruments can be delivered before the start of the 1960-61 academic year. For details, please call any local Picker office (see 'phone book) or write Picker X-Ray Corporation, 25 South Broadway, White Plains, New York.

Hallmark of quality nuclear instrumentation

Picker nuclear

Standing behind every Picker instrument is a local member of the Picker X-Ray national sales and service network.

He's there to protect your investment.

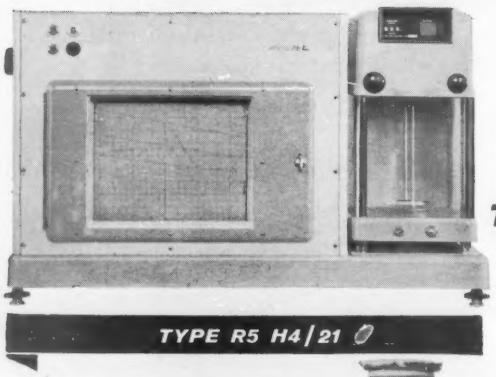
Because of him the user of a Picker instrument is never left stranded.

THE Mettler PAGE

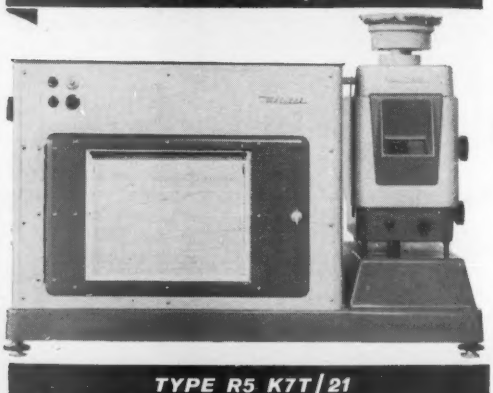
DEVOTED TO NEWS ABOUT TRULY MODERN BALANCES

THREE NEW METTLER RECORDING BALANCES

based on photoelectric scanning of the beam position



TYPE R5 H4/21



TYPE R5 K7T/21

Photoelectric scanning, with a beam of light representing the only link between the moving balance beam and the recording unit, avoids any interference of the recorder with the vitally essential free movement of the beam. Precision and accuracy of the weighing unit are fully maintained and faithfully reproduced.

	TYPE R5 H4/21	TYPE R5 H15/21
Weighing range:	160 g	160 g
Recording range:	1.02 g *corresponding to the optical range of the balance.*	0.102 g
Recording accuracy:	±1 mg	±0.1 mg

Balance: *analytical type, weighing by substitution, pan enclosed in balance housing.*

TYPE R5 K7T/21

Weighing range: 800 g

Recording range: 102 g
corresponding to the optical range of the balance.

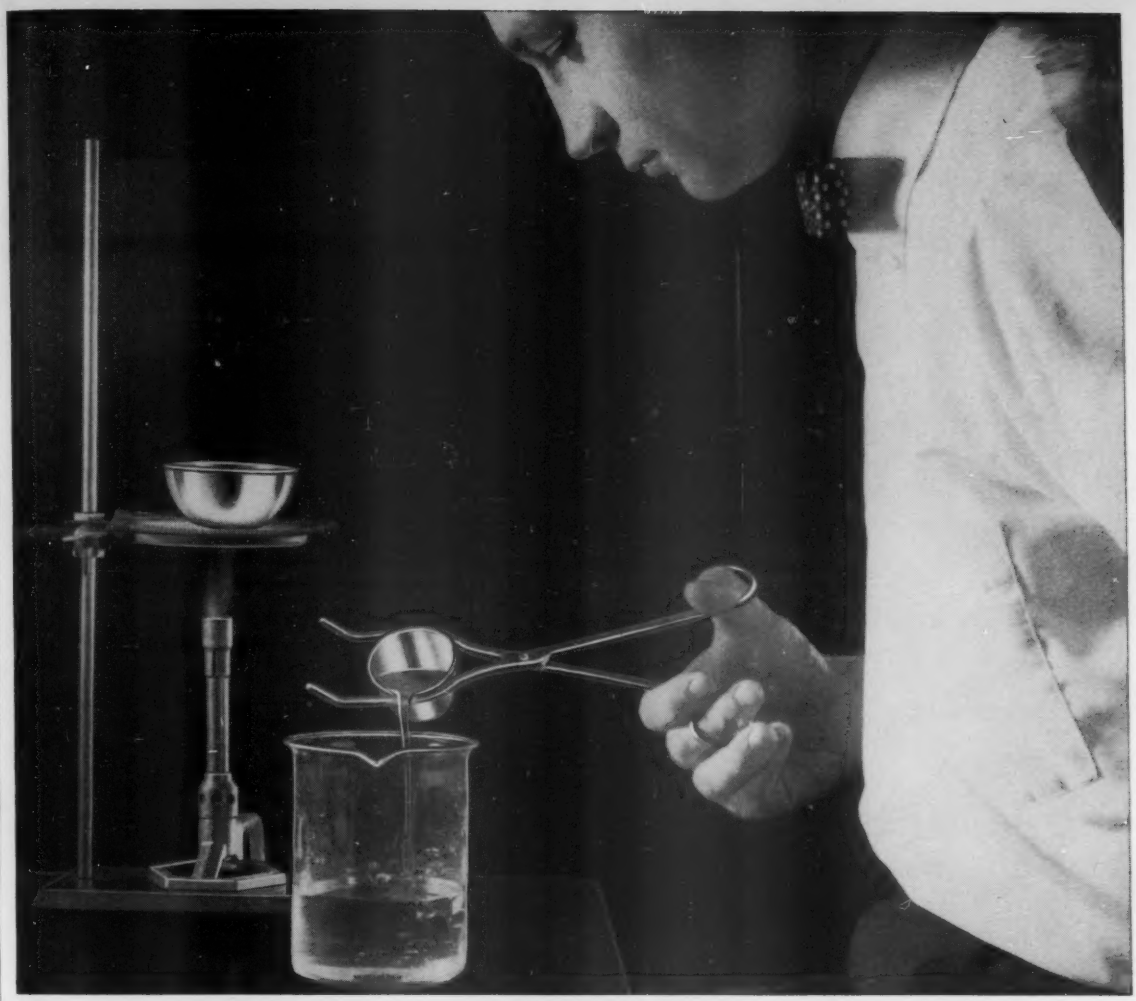
Recording accuracy: ±0.1 g

Balance: *precision type, weighing by substitution, pan unobstructed on top, built-in taring device with 100 g range.*

Both types can be equipped for weighings below the balance, such as in an oven.

Write to us today for our literature describing in detail the performance and construction of the METTLER recording balances.

METTLER INSTRUMENT CORPORATION
HIGHTSTOWN, NEW JERSEY



Handle Corrosive Chemicals Economically

—with Fisher PLATINUM/CLAD Labware!

Chemical, biological and testing labs can now handle corrosive chemicals at temperatures up to 1000°F—without tying up funds in expensive (and often pilfered) equipment. At only one-third the cost of solid platinum, Fisher PLATINUM/CLAD Labware is *four times stronger*, lasts years!

A platinum alloy lining, containing rhodium for improved hardness, is firmly bonded to the stainless steel vessel by a special patented process. The sturdy stainless exterior resists damage from tongs and other mechanical devices; the platinum-clad interior prevents chemical attack. Top edges and spouts are platinum clad and rolled over to prevent reaction with the exterior metal as chemicals are poured.

From stock, Fisher offers PLATINUM/CLAD Crucibles and Evaporation Dishes. You may return this labware when no longer usable for a high scrap refund. (And, since the platinum can be reclaimed only by a special technique, pilferage is reduced.)

Fisher PLATINUM/CLAD Crucibles are $50 each ($45.60 each in lots of 6 to 23; $42.70 each in lots of 24 or more). They are 42 mm in diameter, 42 mm deep, hold 40 cc.

Fisher PLATINUM/CLAD Evaporation Dishes are $64.80 each ($61.60 in lots of 6 to 23; $57.60 each in lots of 24 or more). They are 72 mm in diameter, 33 mm deep, hold 100 cc.

F-149

FISHER SCIENTIFIC

America's Largest Manufacturer-Distributor of Laboratory Appliances & Reagent Chemicals

Boston	Cleveland	Philadelphia	IN CANADA
Buffalo	Detroit	Pittsburgh	Edmonton
Charleston, W.Va.	Houston	St. Louis	Montreal
Chicago	New York	Washington	Toronto

The Model pHM 4

an All-New **pH meter** *developed for research applications by*

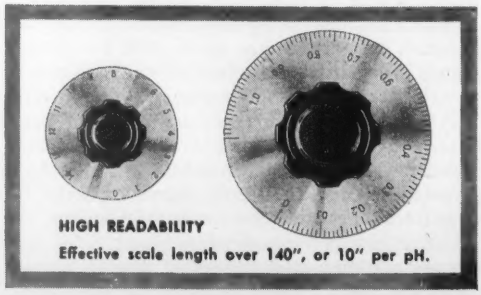
RADIOMETER

- Transistorized
- Potentiometric

We are exceptionally proud of Radiometers latest achievement — a transistorized pH meter which includes these outstanding attributes:

- Very low zero drift.
- Accuracy for pH differences to ± 0.001 pH.
- Accuracy for mV measurements ± 0.2 mV ± 0.05%.
- Reads direct in pH (0 to 14) or mV (0 to ± 1500).
- Uses wide variety of plug-in or remote electrodes.
- Built-in battery condition test and standard cell.
- Uses only two types of readily obtainable 1.5 volt dry cells.
- Wide buffer adjustment range.
- Small view field for minimum eye travel.
- Controls conveniently located.

If your requirements are exceptionally demanding, do not fail to evaluate the Radiometer pHM4. By all means write for further information.



HIGH READABILITY
Effective scale length over 140", or 10" per pH.

J9524

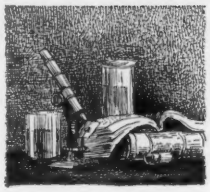
SOLD AND SERVICED IN U.S.A. BY
WELWYN INTERNATIONAL INC.
3355 Edgecliff Terrace CLEVELAND 11, OHIO

RADIOMETER
72 Emdrupvej COPENHAGEN, DENMARK

In Canada: Contact any Branch of Canadian Laboratory Supplies Limited

IT HAPPENED THIS MONTH...

a glance at yesterday in relation to today

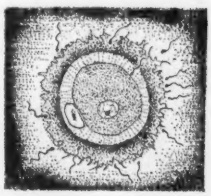


IN SEPTEMBER — (1831) — at the first annual meeting of the British Association for the Advancement of Science, John Dalton[1] reports a series of experiments concerning the relationship of his food consumption to his body secretions. He shows that the carbon content of his diet is 11½ oz. daily, of which there passes off sensibly 1 oz. The carbonic acid gas expelled from his lungs contains 10¼ oz. of carbon leaving ¼ oz. lost as insensible skin perspiration. Mr. Dalton's "regular habits of life and uniform good health" added validity to this self-experimentation.

Modern students of intermediary metabolism have much more sophisticated ways of studying the fate of carbon. Schwarz BioResearch supplies over sixty C^{14}-labeled intermediates, including amino acids, nucleic acids and their component parts, carbohydrates, and metabolic cofactors. Our list of tracer compounds which includes H^3, S^{35}, P^{32} and N^{15} has recently been enlarged by the inclusion of O^{18}-labeled amino acid compounds from the Yeda Research and Development Company, Ltd. at the Weizmann Institute of Science in Israel.

IN SEPTEMBER — (1881) — a physician from Washington, D.C. describes the hair-darkening action of pilocarpin, an alkaloid of the Brazilian drug, jaborandi. A 25-year-old petite blonde lady was given hypodermic injections of pilocarpin hydrochlorate to relieve uremia due to chronic pyelitis. Over a period of months her hair changed from a very light color to almost pure black. Hair on other parts of the body also changed color, and the eyes became a much darker blue. Similar hair-darkening was observed in a 14-month infant given pilocarpin for membranous croup.[2]

Today many biochemists are under the impression that hair color is dependent upon melanin, a product of the oxidative metabolism of the amino acid, tyrosine. Their wives, however, know that external factors may change hair color overnight. Fortunately for the chemist whose true interest is amino acid metabolism, Schwarz can supply amino acids of constant, unchanging *purity. The Schwarz Kit of 18 optically standardized amino acids is suitable for the most precise research or industrial purpose. The box is designed for accessibility, safety, and visibility of contents.*



IN SEPTEMBER — (1910) — speculation concerning the chemical basis of heredity continues. In an address to the British Association Section on Zoology, G. C. Bourne states, "All the evidence at our disposal goes to show that the potentialities of germ-cells are determined at the close of the maturation divisions. Following the physiological line of argument, it must be allowed that in this connection 'potentiality' can mean nothing else than chemical constitution. If we admit this, we admit the validity of the theory, advanced by more than one physiologist, that heritable 'characters' or 'tendencies' must be identified with the enzymes carried in the germ cells."[3]

Half a century later it is clear that the theory would be absolutely valid as stated if we substitute "nucleic acids" for "enzymes." Biochemical geneticists and workers in related fields will be interested in the full line of nucleic acid compounds available from Schwarz BioResearch. We supply DNA, RNA, nucleotides, nucleosides, purines and pyrimidines, sugars and sugar phosphates. Many have been radiolabeled. For example, tritiated thymidine and other H^3-labeled nucleic acid compounds are key tools for genetic studies. Write for our latest catalog and price list.

1. Dalton, J.: On the proportion between the quantity of food and the evacuations. Rep. Brit. A. Adv. Sc., 1831, p. 74. 2. Prentiss, D. W.: Pilocarpin — its action in changing the color of the human hair. Science 2:442 (Sept. 17) 1881. 3. Bourne, G. C.: Address to The British Association at Sheffield. Nature 84:378 (Sept. 22) 1910.

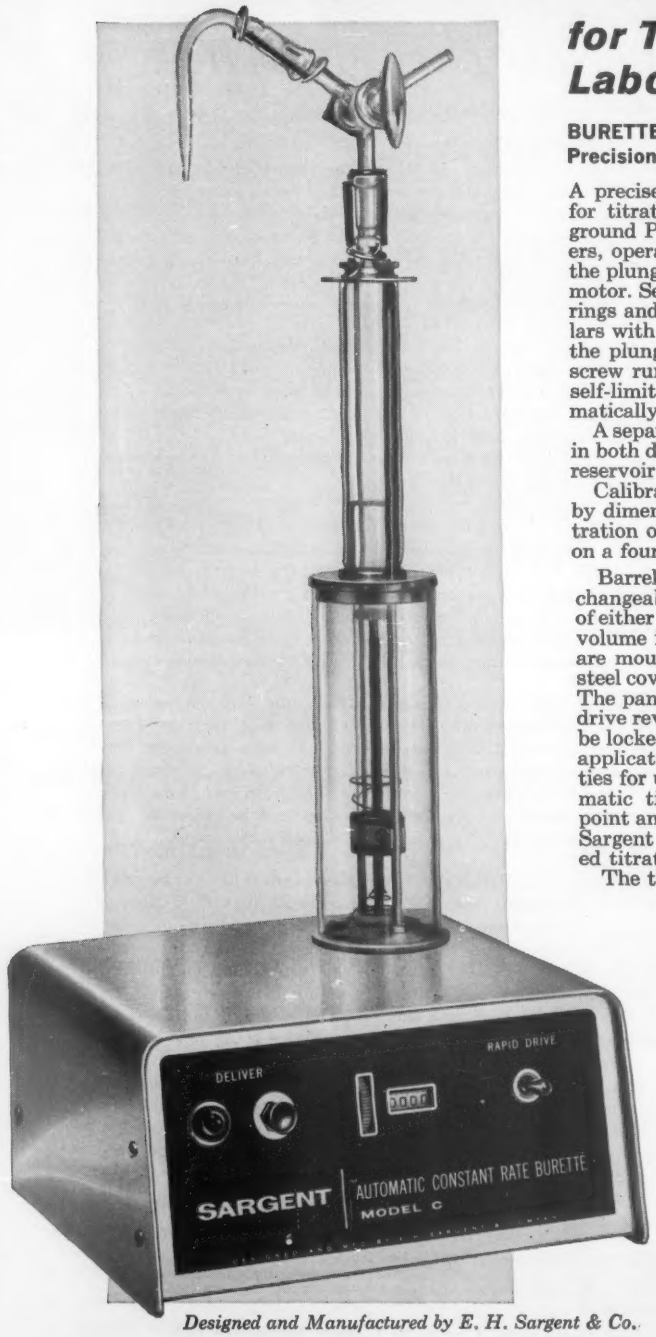
SCHWARZ BIORESEARCH, INC. • Dept. 9B • Mount Vernon, New York

BIOCHEMICALS • RADIOCHEMICALS • PHARMACEUTICALS *for research, for medicine, for industry*

SARGENT

CONSTANT RATE BURETTE

for Titration with Laboratory Recorders



Designed and Manufactured by E. H. Sargent & Co.

BURETTES—Motor Driven, Constant Rate, Precision Grade, 10 or 50 ml, Sargent.

A precise constant delivery device primarily intended for titration with recorders and comprising precision ground Pyrex Brand Glass solution barrels and plungers, operating on a simple displacement principle with the plunger driven at a constant rate by a synchronous motor. Sealing is effected by replaceable Neoprene "O" rings and Quad rings held in special stainless steel collars with spring loading. Motor drive is transmitted to the plunger by a precision ground stainless steel lead screw running in a Nylon following member. Drive is self-limiting at both ends of the lead screw and automatically resumes on reversal.

A separate motor provides rapid motion of the plunger in both directions for refilling from a directly connected reservoir and for discharging excess titrant and flushing.

Calibration of delivered volumes is determined solely by dimensions and rate of travel of the plunger, registration of the resultant delivery volumes being shown on a four digit counter synchronously driven.

Barrel and plunger assemblies are completely interchangeable permitting accommodation of a total volume of either 10 ml or 50 ml. The rate of drive delivers either volume in 10 minutes. Drive and control components are mounted in a cabinet with a protecting stainless steel cover on which the burette assembly is supported. The panel of this case provides pilot light, fuse, rapid drive reversing switch, and starting button which may be locked in for continuous delivery and for automatic applications. The rear panel provides connecting facilities for using the burette with second derivative automatic titrators with automatic shut-off at the end point and for remote operation by direct connection to Sargent recorders S-72150 and S-72151 for fully recorded titrations.

The three-way glass header connects to the burette barrels by a 10/30 ☤ ground joint. The delivery tip is similarly connected to the header by a 10/30 ☤ ground joint.

Accuracy, 0.1% of burette capacity; readability and reproducibility, 0.01 ml with 50 ml capacity, 0.002 ml with 10 ml capacity. Height of base, 5 inches; depth of base, 8¾ inches; width of base, 10 inches; height over header, 23 inches.

S-11120-1 BURETTE—Motor Driven, Constant Rate, Precision Grade, 10 ml, Sargent. With S-11121-1 burette equipment for 10 ml capacity only..... **$280.00**

S-11120-5 BURETTE—Motor Driven, Constant Rate, Precision Grade, 50 ml, Sargent. With S-11121-5 burette equipment for 50 ml capacity only..... **$290.00**

S-11121-1 Burette Equipment Unit, Only, 10 ml. For converting S-11120-5 to 10 ml volume **$27.00**

S-11121-5 Burette Equipment Unit, Only, 50 ml. For converting S-11120-1 to 50 ml volume **$37.00**

SARGENT SCIENTIFIC LABORATORY INSTRUMENTS • APPARATUS • SUPPLIES • CHEMICALS

E. H. SARGENT & CO., 4647 W. FOSTER, CHICAGO 30, ILLINOIS

DETROIT 4, MICH. • DALLAS 35, TEXAS • BIRMINGHAM 4, ALA. • SPRINGFIELD, N.J.

GAMMACELL 220

and

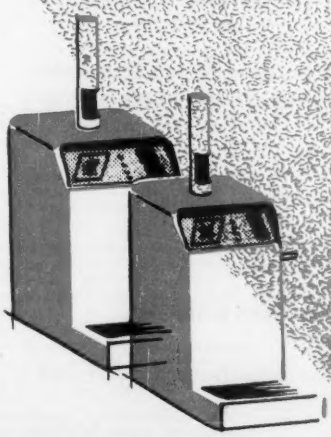
TWO *NEW* GAMMACELLS

TO PROMOTE

ADVANCES IN RADIATION EFFECTS

AECL announces two new Cobalt 60 Irradiators — the GAMMACELL 100 and GAMMACELL 200

All basic features of the field-proven Gammacell 220 are retained in the GAMMACELLS 100 and 200. These two new models extend the Gammacell line to provide facilities where high fields (1,000,000 RH) in small volumes (up to 3½" diameter x 5½" height) are required.



THE GAMMACELL FAMILY FEATURES:

- **SELF-CONTAINED** — No additional shielding required. Simply set it in your laboratory and it's ready to go.
- **THREE MODELS** — with source strengths to suit any program and budget.
- **CHOICE OF DOSE RATES** — to suit your requirements — into the megarad-per-hour range and with good uniformity.
- **INHERENTLY SAFE** — by construction — radiation hazard is no problem.
- **SIMPLE TO OPERATE** — can be used efficiently by unskilled personnel; only incidental maintenance will provide years of trouble-free service.

For full details of the Gammacells 100, 200 and 220, custom irradiators, kilocurie Cobalt 60, consulting services and isotopes, please write to

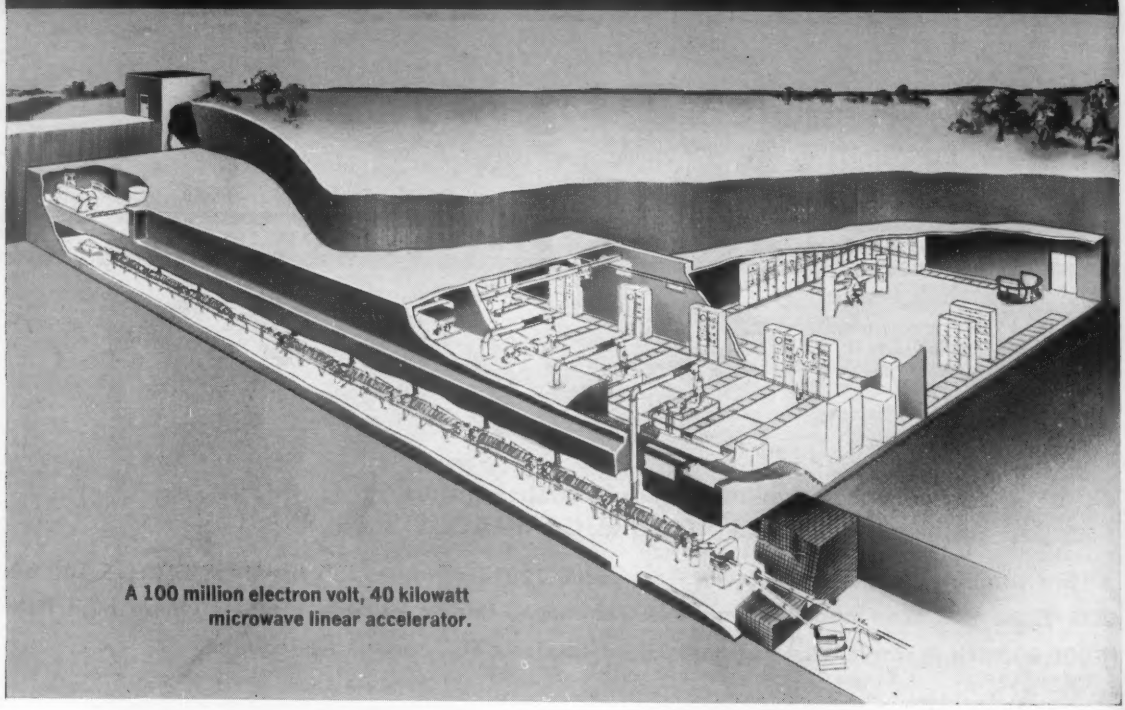
ATOMIC ENERGY OF CANADA LIMITED

COMMERCIAL PRODUCTS DIVISION
P.O. BOX 93, OTTAWA, CANADA

60-3

SETTING NEW STANDARDS

at 99.98% of the speed of light.



A 100 million electron volt, 40 kilowatt microwave linear accelerator.

One of the world's most powerful when completed, this high-energy electron accelerator will enable the U. S. National Bureau of Standards to carry out extensive programs in:

- Nuclear Physics Research
- Radiation Effects
- Dosimetry Standards

... to meet the need for new data in the growing field of applied radiation.

The linear accelerator (Linac) is under construction at the manufacturing and test facility of Applied Radiation Corporation, Walnut Creek, California.

Particle accelerators for science and industry.

HIGH VOLTAGE ENGINEERING CORPORATION

BURLINGTON, MASSACHUSETTS • U. S. A.

APPLIED RADIATION CORPORATION HIGH VOLTAGE ENGINEERING (EUROPA) N.V.

23 September 1960, Volume 132, Number 3430

SCIENCE

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

Board of Directors

CHAUNCEY D. LEAKE, *President*
THOMAS PARK, *President Elect*
PAUL E. KLOPSTEG, *Retiring President*
HARRISON BROWN
H. BENTLEY GLASS
MARGARET MEAD
DON K. PRICE
MINA REES
ALFRED S. ROMER
WILLIAM W. RUBEY
ALAN T. WATERMAN
PAUL A. SCHERER, *Treasurer*
DAEL WOLFLE, *Executive Officer*

Editorial Board

KONRAD B. KRAUSKOPF
EDWIN M. LERNER
PHILIP M. MORSE
H. BURR STEINBACH
WILLIAM L. STRAUS, JR.
EDWARD L. TATUM

Editorial Staff

DAEL WOLFLE, *Executive Officer*
GRAHAM DUSHANE, *Editor*
JOSEPH TURNER, *Assistant Editor*
ROBERT V. ORMES, *Assistant Editor*

BETHSABE ASENJO, CHARLOTTE F. CHAMBERS, SARAH S. DEES, NANCY S. HAMILTON, OLIVER W. HEATWOLE, HOWARD MARGOLIS, ELLEN E. MURPHY, NANCY TEIMOURIAN, DAVID A. TEMELES, LOIS W. WOODWORTH, CONRAD YUNG-KWAI

EARL J. SCHERAGO, *Advertising Representative*

SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at National Publishing Company, Washington, D.C. The joint journal is published in the SCIENCE format. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts and illustrations, see *Science* **125**, 16 (4 Jan. 1957).

Display-advertising correspondence should be addressed to SCIENCE, Room 740, 11 West 42 St., New York 36, N.Y.

Change of address notification should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C., 4 weeks in advance. If possible, furnish an address label from a recent issue. Give both old and new addresses, including zone numbers, if any.

Annual subscriptions: $8.50; foreign postage, $1.50; Canadian postage, 75¢. Single copies, 35¢. Cable address: Advancesci, Washington.

Copyright 1960 by the American Association for the Advancement of Science.

Win the Argument and Lose the Debate

A Soviet-American exchange program that each year includes several dozen graduate students recently yielded instruction on how increased contact between the two countries can also mean increased friction. Some ill-feeling arose when each side rejected some of the candidates offered by the other. The Americans rejected Soviet students on the grounds that they lacked proper preparation for the work they proposed to do or because Soviet officials had not furnished us with sufficient information to place the students properly. The Soviets rejected American students on the grounds that they had selected topics for study that no self-respecting Soviet scholar would touch. One American wanted to study the history of a certain religious sect, while a second wanted to study the work of a 19th-century political thinker named Mikhail Katkov, but the Soviets are not enthusiastic about religious sects and Katkov, it turns out, was an odious reactionary.

In selecting American students with such topics, the U.S. committee handling the exchange was not being unreasonable. A story in the 21 June New York *Times* explained that research in these fields actually is being conducted in the U.S.S.R. And the *Times*, in its 16 August letter columns, documented this claim by scholarly references to the journals *Voprossi Istorii* and *Voprossi Filosofii* and to the researches of Professor Klibanoff and Dotcents Zatpadov and Sladkevich. This documentation was offered in answer to a letter by V. Yelyutin, the Soviet minister of secondary, special, and higher education. Yelyutin charged that the *Times* story was misleading in making it seem as if the U.S.S.R., not the U.S., was responsible for difficulties in the exchange program.

Another American entered the dispute at this point with the suggestion that if we want to promote exchange with the Russians, then the way to proceed is not by appealing to evidence or sweet reason, but by being more accommodating. In a letter in the 4 September *Times*, Bryant M. Wedge, a member of the Yale faculty who has visited Soviet universities, saw little hope of settling East-West differences by discussion. On the question of the U.S. rejection of U.S.S.R. candidates, which the Soviets found surprising in view of the candidates' possession of Soviet college diplomas, Wedge suggested that, even if we are not clear about the students' qualifications or how to place them properly, they should be accepted. Given our large and diverse educational system, he said, we surely can find room for whomever the Soviet ministry chooses to send us.

Accommodation seems to be an excellent ideal in exchange programs, and perhaps we can do more than we have done, not only in accepting Soviet students but in selecting American students—and topics—as candidates for study in the U.S.S.R. As an exercise in imagination, we might consider how certain subjects would affect us if chosen by Soviet students for study here. Suppose a Soviet student wanted to investigate how in Philadelphia in 1787 the bourgeoisie succeeded in strengthening its dictatorship of the country. This topic is not inconceivable. As noted last year by Andrew R. MacAndrew in the *New Leader*, Soviet historiography has it that the American Constitution was established because the American "ruling classes," having turned the revolution to their own selfish ends, realized that the Articles of Confederation could not deal successfully with "the resistance of the masses."

Under the principle of accommodation, it follows that we should welcome the opportunity to correct such a Soviet student's sense of history, but it also follows that we should not seek a similar welcome in the Soviet Union.—J.T.

worth a thousand words...

Let your students see science in action for themselves with these laboratory-proved educational instruments by Bausch & Lomb. They'll understand better, faster—be eager to learn more.

B&L STANDARD TEACHING* MICROSCOPES. Standard size and operation; sturdy, precision construction at school budget prices. B&L STEREOZOOM* MICROSCOPES with continuously variable or fixed magnification. Colorful, erect 3-D images give new life to any subject.

B&L MACROSCOPES* are ideal for gross studies, field trips, dissection. Easy focus, large field of view with 10×, 20×, or 40× magnification. TRI-SIMPLEX* MICRO-PROJECTOR prepares students for individual microscope study. Projects slides or live specimens to wall screen or to table-top for tracing. BALOPTICON* PROJECTORS give big, bright, lasting views of slides, opaque objects, even chemical reactions. B&L SPECTROSCOPES. Basic chemical analysis tools; show spectra of elements. STUDENT-PROOF construction of all instruments gives years of service at a cost to fit any school budget. WRITE for Catalog E-152; demonstration on request. No obligation, of course. Bausch & Lomb Incorporated, 75909 Bausch Street, Rochester 2, New York.

BAUSCH & LOMB
SINCE 1853

*Trademark, Bausch & Lomb Incorporated

23 September 1960, Volume 132, Number 3430 SCIENCE

CURRENT PROBLEMS IN RESEARCH

Guideposts of Migrating Fishes

New findings have added to our knowledge of how fish use olfactory and visual cues to find their way home.

Arthur D. Hasler

Homing in migrating fishes such as the salmon may be defined as a behavior pattern in which an animal spends its early life in one locality and subsequently returns to this locality, after undertaking migratory journeys of long or short duration to areas where the environment is drastically different. Fishes inhabiting smaller bodies of water, such as a stream pool, a pond, or a lake, return readily to a home territory when displaced (*1*), but the homing ability is of far less magnitude in these fishes than in salmon.

The object of this article is to describe and appraise the recent research on homing in fishes, to point up the gaps in knowledge, and to mention a few problems that should be pursued to help clarify differences of opinion. Emphasis is placed on the salmon, for which we have more factual information than for any other group.

There is comparatively good evidence for homing in the Atlantic salmon (*Salmo salar*), the five species of Pacific salmon (*Oncorhyncus kisutch, O. nerka, O. gorbuscha, O. keta, O. tschawytscha*), and the steelhead or rainbow trout (*Salmo gairdnerii*), whose returning migrations constitute a spectacular movement of large numbers of the species as they return to their parent stream to spawn.

In short, salmon spawn in freshwater streams and spend several years (two to seven, depending on the species), at sea, until they reach sexual maturity. Generation after generation, families of salmon return to the same riverlet so consistently that populations in streams that are not far apart follow distinctly separate lines of evolution. During a spawning movement into a river system the majority of fish swim upstream (Fig. 1) until they locate their home creek, where they spawn. In the genus *Oncorhyncus* the adults die after spawning, while in *Salmo*, spawnings are observed in subsequent years.

For a detailed and comprehensive review of migration of fishes, Scheuring's (*2*) splendid monograph is recommended. For relatively recent accounts of the mechanisms of homing, Scheer (*3*) and Hasler (*4*) may be consulted. The eel's life story has been reviewed thoroughly in the excellent treatise by Bertin (*5*), whose volume is available in both French and English, and the life history of the Atlantic salmon was summarized well by Jones (*6*).

Homing ability may be classified into three principal types (*7*): (i) The ability of an animal to find home by relying on local landmarks within familiar territory and the use of exploration in unfamiliar areas; (ii) the ability to maintain a constant compass direction in unfamiliar territory [this type is called *Richtungsfinden (-fliegen)* by Kramer (*8*)]; and (iii) the ability to head for home from unknown territory by true navigation.

Let us review briefly some of the details of homing in the salmon and eel.

The most overwhelming evidence for the precision of homing in salmon is that of Clemens *et al.* (*9*). They marked 469,326 fingerlings in a stream of the Fraser River system and recovered almost 11,000 when the salmon returned there from the sea. Although traps were placed on nearby tributaries, all of the marked fish were captured in the stream of their origin. There were no strays. Other workers report some straying, an aspect of variation; this is as it should be in a biological system. Nevertheless, one cannot but marvel at the accuracy of the majority, for in this drive to return home there appear to be advantages which are of distinct value for survival.

Seemingly, more spectacular than the migration of the salmon is that of the eel, according to Schmidt (*10*), who could trace the migration of the elvers of *Anguilla* from a spawning ground near the Bahama Islands to North America and Europe. After extensive study of the distribution of *Leptocephalus* larvae of the two species of Atlantic eel, he concluded that the adults migrate long distances at sea to spawn and that the young find their way back to their respective continents. Most recently some inadequacies of Schmidt's explanation have been treated by Tucker (*11*), who has suggested an alternative hypothesis—that there is only one species of Atlantic eel and that the European eel population is derived from American spawn which becomes transported via the Gulf Stream to Europe. He supplies arguments as to why the adult European eel could not migrate so far. D'Ancona (*12*), in a brief note, dis-

The author is professor of zoology at the University of Wisconsin, Madison. This article is based on a paper by the author which will appear in *Ergebnisse der Biologie*, vol. 22.

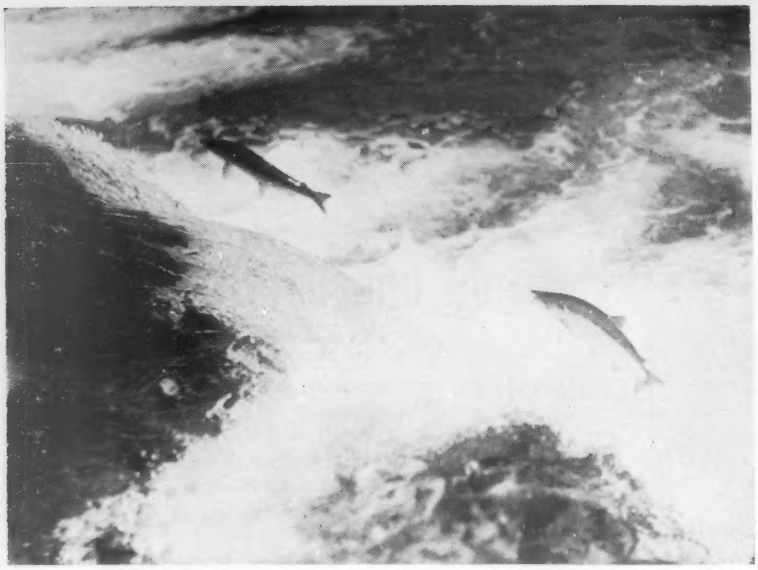


Fig. 1. Salmon ascending falls en route to their home stream to spawn. [U.S. Fish and Wildlife Service]

agrees with Tucker on a number of points, including his main thesis regarding the effect of temperature on the differentiation in the numbers of myomeres of the two groups of elvers as they are transported to North America and Europe, respectively. D'Ancona concludes that this new interpretation of Schmidt's results "requires so many new hypotheses that it is too difficult to accept it on the basis of present knowledge." It is not the object of this article to appraise the Schmidt-Tucker theories in detail; the true explanation can come principally from recaptures of marked adult eels through intensive hauls at sea made in an attempt to fill in the gaps in our knowledge of the oceanic routes of migration. This is an extremely difficult task and may not be accomplished for a long time. There is need for new questions to be posed and for new tests and experiments to be designed to answer them. If the European eel does not cross the Atlantic to spawn, which Tucker claims, are there yet undiscovered spawning grounds nearer to the European continent? Work needs to be done to determine if there is passive transport, or if there is an inherited migratory behavior pattern which makes possible the return to Europe, or if there is active searching. We greatly need more records of adult eels recaptured at sea to unravel the riddle of the eel's life history.

In spite of the impressive evidence of homing in salmon, we still lack a complete record of the migratory path at sea. So far, only a few salmon have been marked in the home stream, caught and remarked at sea, and recaptured in the home stream (*13*).

Recently the Oregon State Game Commission has released a report of remarkable series of recaptures worthy of special attention.

"April 1958: Steelhead fingerling (probably 6 to 8 inches long) released from Alsea River hatchery on the central Oregon coast; marked by removing both ventral fins and the adipose fin."

"September 5, 1958: Captured 75 miles southeast of Geese Island, which is southwest of Kodiak Island, Alaska; fish was 365 mm. long when marked with a 'spaghetti' tag."

"February 5, 1960: Fish was recovered at Alsea River hatchery; 558 mm."

A. C. DeLacy of the University of Washington states (*14*): "This was one of only 59 tagged on the high seas and . . . two others of the group have been recovered in Washington—one in the Samish River (near Bellingham) and the other at Chehalis on the Washington coast. Of course these last two were not fin clipped but they do suggest that the Alsea return does not represent a freak migration."

Each year, through the self-sacrificing and strenuous efforts of fishery biologists from Japan, Canada, and the United States in the wide expanses of the Pacific Ocean (*15*), the gaps in our knowledge of the routes at sea are being filled in. In summarizing the reports of the International North Pacific Fisheries Commission, W. F. Thompson of the University of Washington comments (*16*): "The red salmon of Bristol Bay feeds in great numbers around Attu Island which is 1200 miles from Bristol Bay. We have a great number of tags from that district retaken in our own North American estuaries, particularly Bristol Bay, but not the Gulf of Alaska. Pink salmon spawning in Kamchatka have been tagged all along the Aleutian Islands to a distance of 1200 miles from their own streams. The chum salmon returning to the Okhotsk Sea have been tagged 1700 miles from their home streams. The same is true of chum salmon spawning in Hokkaido. King and steelhead have been tagged in the vicinity of Adak Island and have returned to the Columbia River system and to Washington streams showing a migration of approximately 2500 miles; but Kings and steelheads are taken in very small numbers along the Aleutians. Their main migration is from the waters of southeastern Alaska southward as far as the Columbia River" (Fig. 2).

Donaldson and Allen's (*17*) recent work nicely confirms the findings of earlier work, that homing is not due to genetic factors but is rather the result of some sort of "imprinting" by environmental factors. They switched salmon stock and let the eggs develop in different waters. The fish returned, as adults, after a sojourn at sea, to the waters in which they had been hatched and in which they had lived as fry, not to the parent stream. In fact, Donaldson has now, in this way, built up a run of salmon to a newly built hatchery at the University of Washington on Lake Union.

A Working Hypothesis on Homing of Salmon

While the details of the routes of salmon are still not fully known, it appears justifiable to accept the home stream behavior as a working base. A leading question is: What cues and mechanisms guide these anadromous fishes in their migration? There are two major parts to this question which require an explanation. (i) How do the salmon recognize the main river as well as the home tributary? (ii)

How do they negotiate the route at sea, without visual landmarks?

In an attempt to answer the first question Wisby and I (*18*) have proposed the hypothesis that young salmon are "imprinted" by or "conditioned" to an organic odor of the home stream during their early fingerling period. To state this in simplest terms, we have proposed that the mature salmon, upon reaching the mouth of the home river, would be stimulated to enter because of a characteristic odor. (That is, each stream acquires a different odor which may be derived from a community of plants or their decomposition products in the stream or in the drainage basin.) Subsequently, the salmon would swim constantly upstream, responding positively to the water current. It would reject tributary after tributary until it began to detect traces of the home stream, to which it would respond positively, owing to the early "imprinting." On the way it might make faulty choices but would continue the search after backtracking—a behavior pattern which is frequently observed (*19*).

I would like here to object to the often stated hypothesis that an animal "follows a gradient," because, if an animal stayed in the gradient, it would soon become adapted to the odor (*20*) and would be incapable of responding to it. I think it more likely, therefore, that the behavior during the ascent of the river system is analogous to that of a dog following an odor track. The dog does not stay exactly on the track but progresses along it by crisscrossing, responding to the presence and absence of the scent as it follows its prey. According to this theory, a salmon returning to its parent stream reacts differently to the odor of that stream than to that of any other. In order for a salmon to return to its home stream there must be some possibility of a differential reaction, something more than a simple response to a repellent or an attractant. The guiding odor must remain constant from year to year and have meaning only for those salmon which were conditioned to it during their fresh-water sojourn.

This theory presents three distinct problems. (i) Do streams have characteristic odors to which fish can react? If so, what is the nature of the odor? (ii) Can salmon detect and discriminate between such odors if they do exist? (iii) Can salmon retain odor impressions from youth to maturity?

In order to answer the first question, Wisby and I trained a group of blunt-nosed minnows to discriminate between the waters of two chemically different Wisconsin creeks, one in a quarzitic drainage basin, the other in a dolomitic one (*18*). That scent-perceiving organs were the sole means of discrimination in these tests was proved by destroying the olfactory tissue of trained fishes; after this they no longer responded to the training odors. Chemical analysis of the stream waters indicated that the major difference between them was in the total organic fraction. Experimental evidence to substantiate this was obtained by separating the water into various fractions and then presenting these to trained fishes. The fishes trained previously to react to natural water did not react to the redissolved inorganic ash, or to the distillate or residue of water fractionated at 100°C. However, they recognized the distillate, but not the residue, of water fractionated by vacuum distillation at 25°C—a strong indication that the odorous stimulant is a volatile organic substance.

A test was conducted of the retentive capacities of the trained minnow, and it was determined that even this fish, which is not specialized for long migrations, could differentiate between the odors for a comparatively long period after the cessation of training. Learned behavior was found to be retained longer by young fish than by old ones. Numerous examples are known where animals retain imprinting, or early learning, through to adulthood — circumstantial evidence that odor imprinting can be retained for long periods (*21*).

The method of training which had been used with such success with the minnows was then applied to salmon

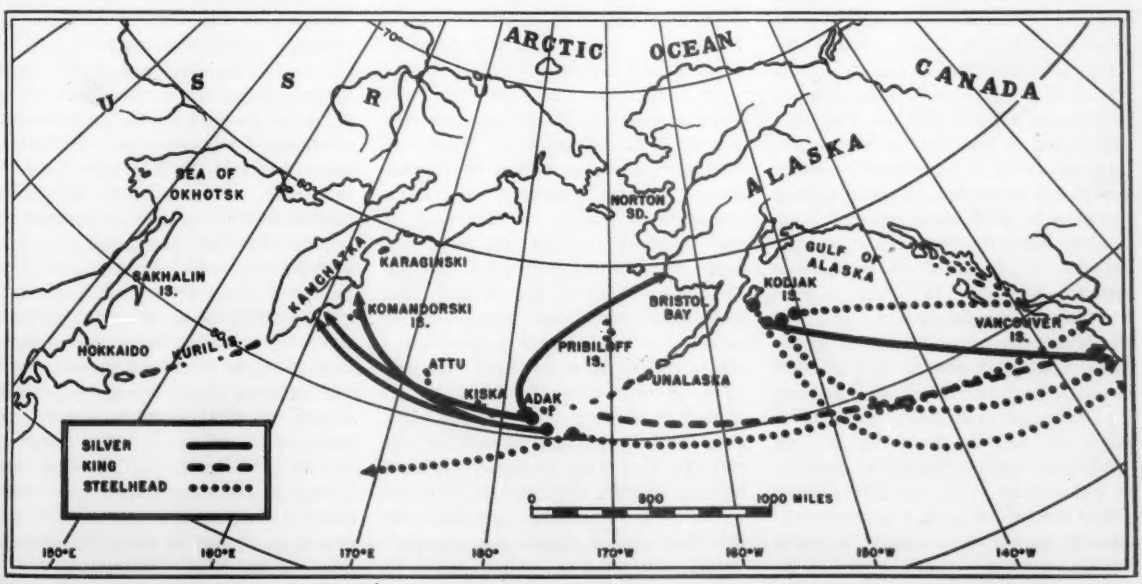


Fig. 2. Generalized distribution of recaptures of king and silver salmon and steelhead trout tagged at sea from 1956 to 1960. The routes shown are the shortest distances between the marking and the recapture points. [International North Pacific Fisheries Commission]

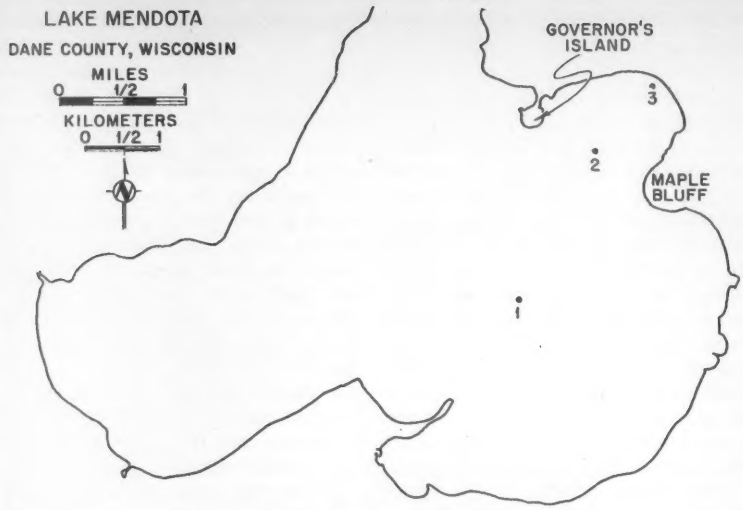


Fig. 3. Map of Lake Mendota. Releases of white bass were made at stations 1, 2, and 3.

fingerlings. After a short period of training it was evident that these fish, too, could discriminate between the odors of water from the two Wisconsin creeks.

Pursuing further this concept of the recognition, by odor, of a home stream, we (*22*) captured sexually ripe coho salmon (*Oncorhyncus kisutch*) at two branches of the Issaquah River in Washington and returned them downstream, below the fork, to make the run and selection of stream again. We plugged the nasal sac of half of the 302 specimens with cotton. The great majority of those recaptured from the other group had again selected the stream of their first choice, while the fish with plugged nasal sacs returned in a nearly random fashion. This field experiment is indicative of the important role that a functional olfactory system has in the orientation of salmon returning to their home stream.

In an effort to further test this hypothesis we proposed to employ an artificial substance to which salmon fry could be conditioned in a hatchery and which could then be used to decoy them, upon their return, into riverlets downstream from the site of conditioning. Moreover, if it proved practical, it might be used to direct fish into rehabilitated streams, formerly dammed or polluted, or to salvage a run which would not be able to pass a newly constructed power dam. Such an odor must be neither a repellent nor an attractant for the unconditioned salmon.

One of my students (*23*) has suggested that the compound morpholine might fit the requirements for this trial. It is soluble in water, thus permitting accurate dilutions; it is detectable in extremely low concentrations, thus making the treatment of large volumes of water feasible; and it is chemically stable under stream conditions. Furthermore, at these low concentrations, it is neither an attractant nor a repellent for unconditioned salmon and thus should influence the behavior of only those salmon that have been previously conditioned to it. Field tests may now be conducted to determine whether salmon fry and fingerlings which have been conditioned to morpholine in a hatchery can be decoyed to a hatchery located on a stream other than that of their birth upon their return to fresh water as migrants. A field experiment of this kind to determine the nature of imprinting is of the highest importance relative to our hypothesis. At least it would be instructive to determine if the "memory" of an artificial odor could be superimposed upon that of the natural odor of the stream. That specific carbon dioxide concentrations in the rivers may serve as guide-posts for migrating fishes has been proposed (*24*). If fishes were found to be attracted or repelled by substances such as carbon dioxide, that would not signify that they were responding to it in homing. Indeed, their homing behavior would seem to preclude the possibility that they are so attracted or repelled. If this were the case, salmon might be expected to follow a chemical track regardless of their origin.

Recently, Teichmann (*25*) has examined the olfactory acuity of the eel with respect to pure chemicals and has found it to be remarkably high. Concentrations of 3×10^{-30} of β-phenylethylalcohol were detected by young eels conditioned by training to these chemicals. If 1 milliliter of the compound were diluted to this concentration, the volume of liquid would be of an order of magnitude 58 times the volume of the Lake of Constance (the Bodensee). Teichmann (*25*) computed that the amount of the chemical in the eel's olfactory sac at this concentration would be as little as two or three molecules.

If and how, in migration, eels use this sense is not known; however, Creutzberg (*26*) suggests that elvers use the olfactory sense in discriminating between the water of ebb and flow tide and are hence able to take advantage of the transport of the flow tide in bringing them from sea to fresh water. In laboratory tests he found that elvers were not able to discriminate between ebb and flow waters after the water had been filtered through charcoal. The odor can be presumed to be organic in nature.

Contemplation of the various roles that olfaction might play in eel migrations is provocative, and the opportunity to discover new mechanisms awaits the imaginative and industrious investigator.

In the ocean, it seems to me, odor might play a role principally by giving the fish a sign stimulus for home recognition. If the fish were swimming within a water mass, it would have no sense of being displaced, as the mass moved, unless there were fixed visual or tactile features in the environment; (compare the experiences of balloonists in a cloud). On the other hand, in the place of contact of two water masses there might be differences in salinity, dissolved gases, and odor (*4*) that possibly could be perceived. Unpublished data from our laboratory have convinced us that the minnow can smell the difference between water from Georges Bank and samples from the Sargasso Sea. When two water masses met there might be a sliding of one over the other—a "shear effect"—that would help the fish to sense that it had reached the edge of a water mass, stimulating it either to enter the new mass or stay in the water mass in which it had been swimming.

The sensing of salinity, gases, or odors at any one place at sea would appear to me to be signals for recog-

nizing, for example, an oceanic spawning site once the fish had arrived rather than cues for directional orientation.

In this article I may have overstressed the olfactory sense and its importance in migration, but I hasten to acknowledge the many limitations of our results and the need for much more work to fill in the gaps in our knowledge. As I contemplate the role of olfaction in salmon migration I believe it to be, above all, useful to a salmon within a stream system, far less useful in the open sea.

Open Sea Orientation

While home-finding in a stream system may depend upon the recognition of an odor and on other yet undiscovered guideposts, it seemed to me that the olfactory hypothesis was inadequate to explain the movements of salmon in the ocean. Certainly other cues are used.

Since it was abundantly clear that a Wisconsin team would have difficulty in conducting field studies on salmon at sea, I then asked myself the question: Is there a fresh-water fish which must find its spawning ground from open water? If so, then the mechanism of open-lake orientation in such a species might give us a clue as to how the salmon accomplishes these feats at sea.

Our initial attack on this problem consisted of study of a less complex type of homing than that in salmon. For a number of years my co-workers and I (*27*) have studied the natural history of the white bass (*Roccus chrysops* Raf.) in Lake Mendota, Wisconsin; we have been able to locate only two major spawning sites in the entire lake, and these are of very limited area. These spawning grounds, Maple Bluff and Governor's Island, are both on the north shore of the lake and are separated by a distance of 1.6 kilometers (Fig. 3). Here the white bass congregate at spawning time in late May and early June, when temperatures range from 16° to 24°C.

During three different spawning seasons (1955, 1956, and 1957) white bass were captured in fyke nets, marked with numbered disk tags, and transported in open tanks to the different release stations in the lake for daytime releases.

From the start, we observed that a large percentage of the displaced fish returned and were recaptured in nets; moreover, as the observations accumulated we were impressed with the high percentages of recapture (89 to 96 percent) among the Maple Bluff and Governor's Island spawners. They returned to their original spawning site from a release point located 2.4 kilometers from the spawning grounds, in a lake having an area of 39.4 square kilometers and a shoreline of 32.4 kilometers. For tagged fish released on the spawning ground without being displaced the percentages for recapture and for time lapse between release and recapture were of the same order of magnitude as those for fish that were displaced. This would indicate, therefore, that there was an almost complete return of the displaced fish to a spawning ground, it being assumed that mortality of the two groups was similar, that the efficiency of the net was constant, and that the nondisplaced fish remained as a catchable portion of the fish in the spawning grounds.

Subsequently, the "take-off" direction of displaced white bass was observed. To the fish was attached a plastic float (Fig. 4), which could be followed as the fish towed it along. More refined methods of tracking are currently being tested in our laboratory. The releases reported by my co-workers and me in 1958 (*27*), and many additional releases since then, continue to convince us that the course taken upon release is generally north, toward the spawning grounds, on sunny days. On cloudy days, however, the fish swim randomly. It would appear that this tendency to take off toward the north serves the purpose of bringing the fish promptly to shore in the general vicinity of the spawning areas. Once there, they appear to locate their specific spawning areas by other cues. Orientation of type (ii) discussed above appears, then, to characterize the white bass of Lake Mendota.

How might this mechanism of orientation be explained? While we were investigating the field aspects of this problem, the classical studies of von Frisch (*28*) and Kramer (*29*) on sun orientation had been published. I considered it important to explore the possibility that a sun-compass mechanism could be helpful to fish in open-water migration. To expose this notion to laboratory and field tests, new methods and apparatus had to be developed. In addition, we had to determine what fish were most suitable for this type of laboratory experiment.

The principal method which we developed to test for sun orientation relied upon an escape, or cover-seeking, response, which was used for scoring. The fish were tested under the open sky in a specially designed tank (Fig. 5) (*27*). During training the fish usually attempted to seek cover and found it

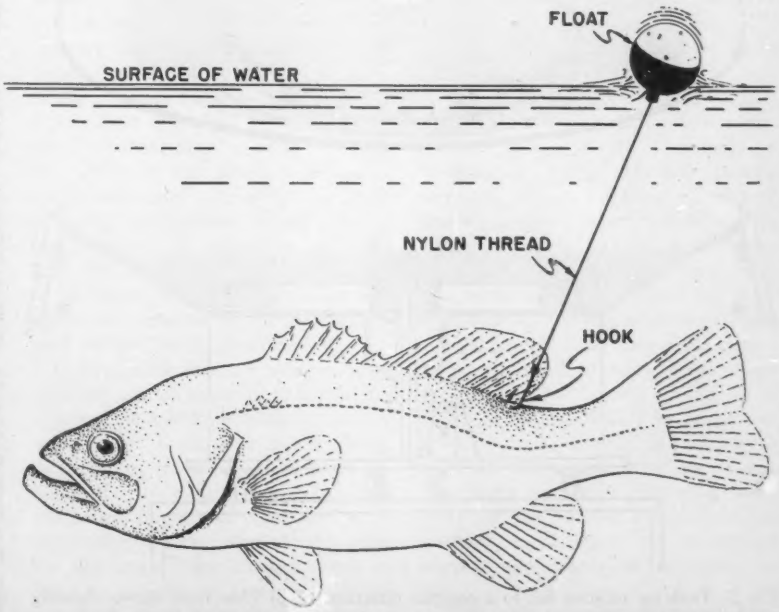


Fig. 4. A method for tracking displaced fish in order to measure the accuracy of their direction of take-off.

in only one of the 16 small compartments, within 360°, the others having been covered by a metal band. The arrangement of the small containers was such that they could not be seen by the fish from its starting point in the middle of the large tank. Training tests were conducted at frequent intervals. In this process the fish was removed from the small container and placed in a cage in the center of the tank. Upon release it was given a small electric shock to frighten it. This resulted in the fish's seeking cover again in the small open container, which was always in the same compass direction.

Tests were then conducted with all 16 of the boxes open and available to the fish. When it was determined that the fish had learned the location of the box which lay in the same compass direction as the training compartment, the critical tests were begun. The tests were made between 0800 and 0900 hours and 1500 and 1600 hours CST. All 16 small containers were available for entry, but usually the fish chose those which lay in the compass direction in which it had been trained to seek shelter.

The trained fish were disoriented when tested under completely overcast skies, at times when the experimenter could not detect the presence of the sun. This demonstrates that the sun was the fish's point of reference and that the fish had learned to seek cover in the same direction at different times of day—that is, to allow for the movement of the sun (see Fig. 6).

The crucial and definitive test was then conducted—namely, substitution of an artificial "sun," indoors, for the actual sun. A sun-compass fish responded as though it were responding to the real sun out-of-doors at that time of day, choosing a hiding box at the appropriate angle to the artificial sun. Hence, the existence of an orientation rhythm which is associated with the so-called "biological clock" has been established.

It now becomes imperative that field studies be made of migrating salmon at sea. Sexually mature salmon should be captured in purse seines near the mouth of a home river, equipped with tracers similar to those described above for the white bass, and displaced several kilometers out to sea, and their "take-off" and swimming direction should then be charted.

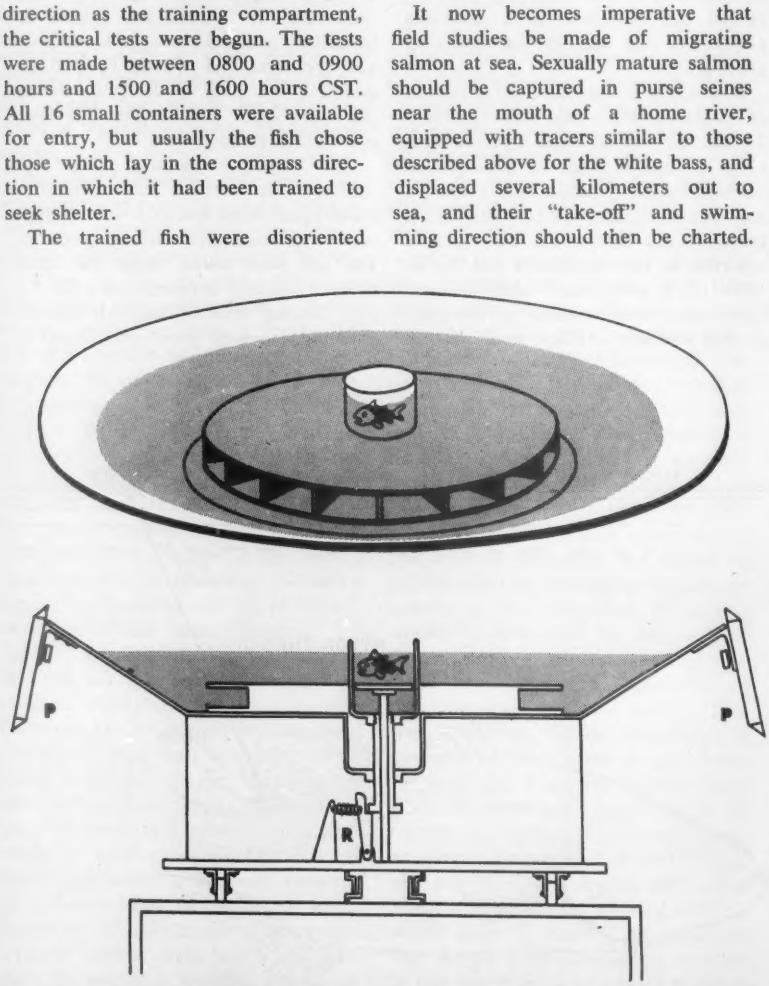


Fig. 5. Tank for training fish to a compass direction. (Top) View from above, showing the hidden boxes. (Bottom) Side view, showing periscopes (*P*) for indirect observation and the release lever (*R*) used to permit the cage to be recessed by remote control when the fish is released.

Future Research on Open-Sea Navigation

From field and laboratory evidence, compiled from four different species of fresh-water fish, it is clear that many fish possess a sun-compass mechanism, and of importance here are the results of our unpublished laboratory tests on young silver salmon, which show that they too have this mechanism for orientation.

We cannot stop here, because a salmon with a sun-compass mechanism needs augmentive sensory and physiological abilities to accomplish the migratory feat it appears to perform.

If it could be shown that salmon do swim in a constant compass direction when the sun shines and that they cannot do so under a completely cloud-covered sky, the evidence would be clear. On the other hand, negative results in both cases could be due to excessive handling, but positive results, with and without the sun, would point toward orienting mechanisms other than our hypothetical sun compass.

If salmon could maintain a compass course in the open sea, even a slight drift with currents would displace them to such great distances that they would be driven to shore hundreds of kilometers from their home-river system (see Fig. 2).

Possible Influence of Sun Altitude

Perhaps there are other cues which are perceived in navigation. Celestial cues may not be the only significant ones.

In seeking an understanding of the mechanism of the sun compass in animals, the application of laboratory methods has been extremely illuminating. Nevertheless, it must be kept in mind that these methods have not provided us with an explanation of navigational ability.

The results from field tests have established navigational ability in birds (*30*), but such ability requires, in addition to the sun-compass type of orientation, some other factors, such as those that enable homing pigeons, for example, to find their home loft after being released at distant, unfamiliar places. For salmon, comparable field tests have not been made, even though oceanic migration appears to demand some type of navigational ability.

The take-off directions of the white bass when released out of sight of shore in the middle of a large lake (*27*) support the view that at least one species of migrating fish uses its ability to maintain a compass direction when the sun is visible. This sun-compass mechanism in fish appears to be quite similar to that found in invertebrates (*28*) and in birds (*29*). Other characteristics of the sun-compass mechanism, as judged from laboratory tests, lead to further fruitful avenues of exploration into the nature of the physiological mechanisms involved.

Braemer (*31*) simulated drastic longitudinal displacements with trained fish by shifting their "time sense." He did this by conditioning them to light cycles which were delayed or advanced from those of their normal day. When these fish were tested out of doors, he found that the compass direction which they now indicated deviated by a definite angle from the previous direction. This deviation was roughly equivalent to the amount of shift in time (or longitude). When testing these fish during the noon hour, he observed that the zenith position of the sun could be correlated with a partial reorientation which resulted in choices that were in the compass direction of take-off of their training period.

This result suggests that the altitude of the sun plays a role in orientation.

In order to shed further light on this point Schwassmann and I (*32*) flew some sunfish (*Lepomus cyanellus*) that had been trained in orientation to the sun for several weeks at Madison, Wisconsin (43°N), to the equator at Belém, Brazil (1°S), where we tested them out of doors in our circular sun-orientation maze (Fig. 5). These fish did not adapt to this new and radically different daily sun movement but continued to make the compensation for the azimuth curve of the sun that would have been "correct" for Madison. One of these sunfish, when flown to Montevideo (30°S) and retrained briefly under the sun (which appears to move counterclockwise in the Southern Hemisphere) continued to make the adjustment that would have been correct for the Northern Hemisphere. What would have been the response of a sexually mature salmon that had moved from one latitude to the other at a normal and gradual rate?

Under the equinoctial sun at the equator a rapid deterioration of the oriented behavior of the displaced fish occurred, and all the fish showed an increasing tendency to maintain one and the same angle to the azimuth position of the sun throughout the day. Because of the somewhat preliminary nature of this experiment, no definite conclusion can be drawn as to the probable cause of this behavior.

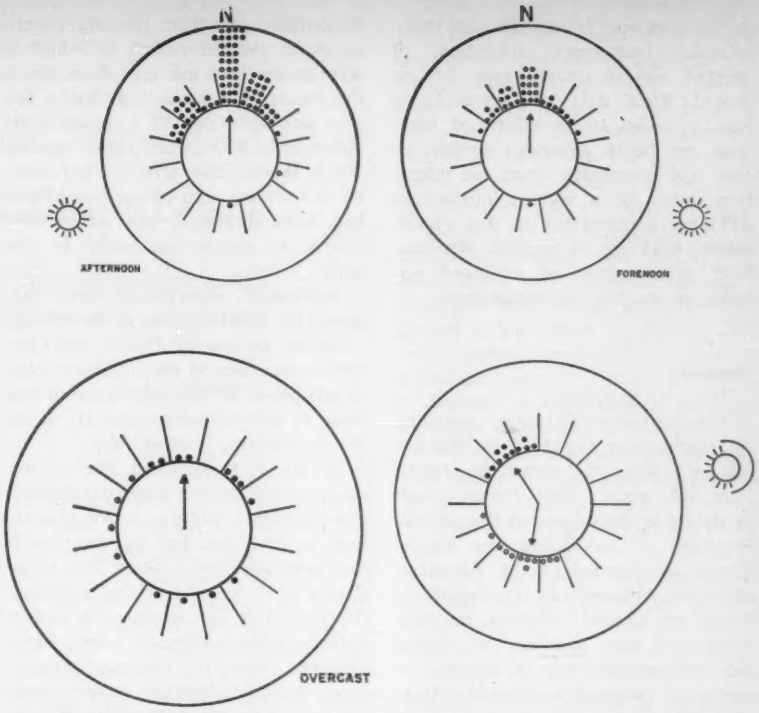


Fig. 6. Scores of a fish trained to north. Scores of the fish (top left) tested in the afternoon, with 16 possible choices; (top right) tested in the forenoon, with 16 possible choices; (bottom left) tested under completely overcast skies on two different days; (bottom right) tested with an artificial light, the angle of altitude being the same as for the sun (solid circles, scores in the forenoon; open circles, scores in the afternoon).

It is clear that other types of studies must be undertaken in order to solve the riddle of the salmon's migratory accomplishments. Certainly we must be boldly imaginative in approaching the problem, by going to sea with new techniques and logical hypotheses to be tested and returning to the laboratory to elaborate on the mechanisms used by the fish to find its way.

Is it possible that the salmon, upon reaching sexual maturity, accumulates a certain temperature budget within a water mass in which it is swimming, as it obeys direction from its sun compass? Its subsequent deviation from this course might take place only when this budget was exceeded. At this point the fish might take another angle to the sun in order to correct its course and keep from being drifted too far off course. This is no doubt too bold a hypothesis, but it is this type of thinking which will be required as we take the next step of the many which will be necessary before the complete behavior pattern is deciphered.

Adult salmon are known to move during the night in the sea. In order to take advantage of this activity the gill-net fishermen set their nets at night. Clifford Barnes of the University of Washington (*33*) observed salmon migrating at right angles to his oceanographic research vessel, which was on course at night in the northeastern Pacific. Because of a luminescent sea, this school of large salmon could be seen clearly. The fish swam on a fairly straight course until they were out of sight. We need to know more about the directed movements of salmon at night. We badly need a technique for tracking them, in order to gain knowledge of their night activities at sea. The work on night migrating birds (*34*) and the possible influence of star patterns as beacons for orientation suggest new points of reference for fish.

The tuna constitute another group of fishes which make long migrations

in the open sea. Transpacific and transatlantic (east-west) migration of marked and recaptured tuna are on record. Field data are accumulating rapidly, owing to the efforts of Japanese and North American workers as they add knowledge about the migratory routes. Soon, enough information will have accumulated so that experimental work can be planned. We have here opportunities of unlimited potentiality, exciting to contemplate.

Summary

The pertinent literature regarding the mechanisms employed by sexually mature salmon in order to return from the sea to their home stream or rivulet is the subject of this article. Emphasis is placed on the Pacific salmon as reported in the American literature. Although the migrations of the eel are alluded to briefly, the new theories of odor and sun orientation and their possible role in homing of salmon are reviewed in somewhat greater detail.

In salmon two main phases of homing are stressed: (i) the finding of the home stream or rivulet after the main river has been reached and (ii) migration from long distances at sea to the rivers. The oceanic migration seems to demand an ability to navigate—that is, to return home from a distant place in an oriented fashion and not by random searching.

In the river system, it is proposed, a young salmon becomes "imprinted" or conditioned to the odor of its parent stream. After three to five years at sea and during the return river migration, it swims against the current, rejecting all odors, until it arrives at the home tributary to which it has been initially conditioned. Circumstantial evidence is cited in support of this hypothesis: (i) from training experiments in the laboratory, in which it was shown that fish can discriminate the scents of streams and that a fish may retain the odor of a stream in its "memory"; (ii) from field studies, which showed that after normal salmon and salmon with plugged nasal sacs had been displaced, the latter were unable to return accurately to the home stream.

Additional experiments are suggested for definitive tests of the theory.

Recent studies by Dutch and German researchers on the olfactory sense of eels points up the importance of this sense in orientation, particularly as an aid for locating a river inlet.

At sea, it is proposed, the salmon may possess, among other capabilities, a sun-compass mechanism for orientation, as first described by von Frisch for bees and by Kramer for birds. Recent work has shown that a pelagic American lake fish employs the sun in order to strike a compass course when displaced from its spawning ground near shore. Laboratory experiments prove that several fresh-water fish, in addition to young salmon, have a sun-compass mechanism, but true navigation in fish has not yet been demonstrated by field studies.

Some of the unsolved problems are stressed here, and suggestions are made for future observations and for experiments which should be performed in future investigations of the remarkable feat of homing in the salmon. An increased effort, by the International North Pacific Fisheries Commission to capture and mark thousands of Pacific salmon on the high seas is filling the gaps in our knowledge about the routes of salmon at sea. Comparable efforts are needed in order to obtain records of the oceanic movements of eels, tuna, and other fish which migrate long distances.

References and Notes

1. A. D. Hasler and W. J. Wisby, *Ecology* **31**, 289 (1958); S. D. Gerking, *Biol. Revs.* **34**, 221 (1959).
2. L. Scheuring, *Ergebn. Biol.* **5**, pt. 1, 405 (1929); *ibid.* **6**, pt. 2, 4 (1930).
3. B. T. Scheer, *Quart. Rev. Biol.* **14**, 408 (1939).
4. A. D. Hasler, *J. Fisheries Research Board Can.* **11**, 107 (1954).
5. L. Bertin, *Eels: A Biological Study* (Cleaver-Hume, London, 1956), p. 192 [*Les Anguilles* (Payot, Paris, 1942), p. 218].
6. J. W. Jones, *The Salmon* (Collins, London, 1959), p. 192.
7. D. R. Griffin, *Am. Scientist* **41**, 209 (1953).
8. G. Kramer, *J. Ornithol.* **94**, 201 (1953).
9. W. A. Clemens, R. E. Foerster, A. L. Pritchard, in "Migration and Conservation of Salmon," *Publ. Am. Assoc. Advance. Sci. No. 8* (1939), pp. 51–59.
10. J. Schmidt, *Rapp. Conseil Exploration Mer* **5**, 137, 267 (1906)
11. D. W. Tucker, *Nature* **183**, 495 (1959).
12. U. D'Ancona, *ibid.* **183**, 1405 (1959).
13. A. G. Huntsman, *Science* **95**, 381 (1942); A. L. Pritchard, *Fisheries Research Board Can. Progr. Repts. Atlantic Coast Stas. No. 57* (1943), pp. 8–11; A. A. Blair, *J. Fisheries Research Board Can.* **13**, 225 (1956).
14. A. C. DeLacy, personal communication.
15. *Intern. North Pacific Fisheries Comm., Vancouver, B.C., Ann. Repts.* (1956–1958); A. C. Hartt, *Univ. Wash. Fisheries Research Inst. Circ. No. 106* (1959).
16. W. F. Thompson, personal communication.
17. L. R. Donaldson and G. H. Allen, *Trans. Am. Fisheries Soc.* **87** (1957), 13 (1958).
18. A. D. Hasler and W. J. Wisby, *Am. Naturalist* **85**, 223 (1951).
19. W. E. Ricker and A. Robertson, *Can. Field-Naturalist* **49**, 132 (1935); W. Wickett, *Fisheries Research Board Can. Progr. Repts. Atlantic Coast Stas. No.* **11** (1958), pp. 18–19.
20. T. J. Walker and A. D. Hasler, *Physiol. Zoöl.* **22**, 45 (1949).
21. W. H. Thorpe and F. G. W. Jones, *Proc. Roy. Soc.* (*London*) **B124**, 56 (1938).
22. W. J. Wisby and A. D. Hasler, *J. Fisheries Research Board Can.* **11**, 472 (1954).
23. W. J. Wisby, thesis, University of Wisconsin (1952).
24. E. B. Powers and R. T. Clark, *Ecology* **24**, 109 (1943); G. B. Collins, *U.S. Fish Wildlife Serv. Fishery Bull. No. 52* (1952), pp. 375–396.
25. H. Teichmann, *Naturwissenschaften* **44**, 242 (1957).
26. F. Creutzberg, *Nature* **184**, 1961 (1959).
27. A. D. Hasler, R. M. Horrall, W. J. Wisby, W. Braemer, *Limnol. Oceanog.* **3**, 353 (1958).
28. K. von Frisch, *Experientia* **6**, 210 (1950).
29. G. Kramer, *Naturwissenschaften* **37**, 188 (1950).
30. G. V. T. Matthews, *Bird Navigation* (Cambridge Univ. Press, Cambridge, England, 1955), p. 141.
31. W. Braemer (working in our laboratory), *Verhandl. deut. zool. Ges.*, in press.
32. A. D. Hasler and H. O. Schwassmann, *Cold Spring Harbor Symposia Quant. Biol.*, in press.
33. C. Barnes, personal communication.
34. F. Sauer, *Z. Tierpsychol.* **14**, 29 (1957); F. C. Bellrose, *Wilson Bull.* **70** (1958), p. 20.

Birds, Bees, and Ballistic Beasts

Air Force basic research in biology may provide clues for improving missile detection and computers.

B. G. Holzman

While the public has become increasingly informed of the use of dogs, cats, rats, and monkeys in medical research, the use of some of our lower or more exotic forms of life in biological research gives rise to comments about their significance for human or Air Force problems. It almost seems as if some of this feeling harks back to our culturally old and deep-seated dread of lowly life forms. I am reminded of the fairies in *A Midsummer Night's Dream*, who sang:

You spotted snakes with double tongue,
Thorny hedgehogs, be not seen;
Newts and blind-worms, do no wrong,
Come not near our fairy queen. . . .
Weaving spiders, come not here,
Hence, you long-legg'd spinners, hence!
Beetles black, approach not near;
Worm nor snail, do no offense.

Thus, when my scientists in the Air Force Office of Scientific Research report studies in which bats, beetles, electric fishes, octopuses, or bobolinks have been used, we are met with either tolerant amusement or slightly veiled ridicule, and in official circles, up to and including congressional levels, we seem to invoke incredulity, alarm, or special inquiry.

I am therefore reluctant to admit that our interests also extend to blind fish, waltzing mice, congenitally deaf cats, eels, ants, locusts, lizards, porpoises, crickets, scorpions, praying mantes, fighting fish, newts, spiders, and toads, to mention only a few. But one thing we can be sure of, and that is that no one will be indifferent. Animals are familiar and provoke some response, be it protectiveness, acquisitiveness, gustatory anticipation, endearment, amusement, revulsion, or fear. I sometimes envy my scientists in physics, mathematics, and chemistry, who can report with relative impunity on the inanimate objects of their studies. Their reports are usually received with solemnity and respect, if not understanding. Paramagnetic resonance, neutrinos, magnetohydrodynamics, microwaves, excited states, Boolean algebra, ergodic theory, and intergalactic dust, are, after all, nothing to joke about, even if eyebrows may be raised occasionally over such things as Lie groups, pi mesons, Love's theory, Green's function on a Brown Space, or the backside of the moon.

The author, a brigadier general in the U.S. Air Force, is vice commander of the Air Force Research Division, Air Research and Development Command, Washington, D.C.

Biology and Engineering

Knowledge of the fundamental workings of the life process can have far-reaching military implications, as well as civil and humanitarian values. The improvements to be achieved in human performance and tolerance to stress are closely related to medical interest in control of disease and are well known. But less well known is the potential application of biology in engineering. Our physical scientists are making slow progress in building complex computer devices that can imitate the element of judgment characteristic of animal or human behavior. So far, machines can do what they are programmed to do, but can do little learning. Engineers now look with renewed interest on the ways nature has solved her control and communication problems. Nature has served as a vast laboratory for over two billion years and has made uncountable experiments. This vast evolutionary process has resulted in a fantastic wealth of animal types, many with unique and highly developed characteristics far beyond those of man. Therefore, I think it is of great importance to engineers that we are looking at all kinds of special senses in animals, and at the kinds of nervous control exhibited by even the simpler forms of life. The comparative approach to the solutions of biological problems has been a profitable strategy in the past and will undoubtedly be expanded as biology becomes a more quantitative and analytical science. I don't see how we are going to avoid getting tangled up in all this, as additional curious forms of life are brought under scrutiny.

A better understanding of man's behavior is recognized to be critical for the broad areas of selection, training, and efficiency. Since behavior depends upon differentiation within the central nervous system, the correlation of behavior with nervous activity should be as broad as possible and should not overlook the highly developed and stereotyped behaviors of certain species which may exemplify a relatively simple correlation between nervous structure and function. It should be far simpler to analyze the nervous system of an insect with a few nervous components than to tackle the intricate and frightening networks that comprise the nervous system of a rat or a monkey or man.

There is frequent talk that the manned bomber is obsolete, and those who won't believe this are immediately dubbed perpetuators of a "cavalry of the air." Missiles are all the rage. But the missile is a stupid beast. It only goes where you tell it to go. If you don't know where to send it, it is virtually worthless. A manned bomber is infinitely more versatile than a missile. But a missile operated by a computer that works like a man's brain would indeed make the manned bomber obsolete. And this, among other things, is what we are searching for in our biology basic-research program.

A dividend that can accrue from studies of diverse species is the derivation of models that can be the basis for development of useful electronic equipment. Despite the simplicity of their structure and the tiny mass of their essential components, these animals perform complex chores beyond the capability of the most sophisticated computers available today. An understanding and utilization of these biological principles can almost certainly lead to an increase in the versatility and a decrease in the size of future instruments. This is not to say that we would want to imitate the components of nature's

systems, any more than our use of aerodynamic laws employed by the birds implies that we must build airplanes out of feathers. It is the laws of organization and information processing that we are most in need of. And if we get ideas for better components, that will be an added dividend.

Animal Senses

Some of the implications and uses of animal sensing devices have already been reported elsewhere. For example, a mathematical model of the beetle's vision is the basis for the development of a ground speed indicator. The use of ultrasonic cries for echolocation by the bat is well known, if not yet fully understood. Its precision, speed, and freedom from interference make this a profitable system for study by the physicist, not only for military purposes but as an aid to the blind. The sensitivity of the moth's ear in intercepting hostile bat sounds surpasses that of our most advanced microphones. The sonar system of porpoises and whales has been little studied, but evidence indicates that they have a highly developed and accurate location sense combined with a high degree of intelligence and ability to communicate. An institute is now being formed in the Virgin Islands dedicated to the study of these animals.

Other animal sensing devices are perhaps less well known but appear to the practical-minded to have equal potentialities. Many fish have electroreceptors which they use to detect obstacles. These fish emit pulses of low voltage with frequencies characteristic for each species. The frequencies may range from 50 to 1600 cycles per second. The alteration of the pattern of the electric field as a result of objects, apertures, or other fish in the surrounding water can be detected. So sensitive is this response that the fish will respond to the movement of electrostatic charge produced by waving a comb (that has been run through one's hair) in front of the aquarium. They can differentiate between a conductor and a nonconductor or respond to the presence of a stationary magnet outside the aquarium. It has been calculated that these fish are sensitive to a change in field of the water around them of 0.003 microvolt per millimeter, a fantastically minute alteration.

The rattlesnake is equipped with exquisitely sensitive temperature receptors. These receptors will respond to an increase or decrease of 10^{-21} calorie (small) in 0.1 second, which represents a change in tissue temperature of 0.001°C. Expressed in terms of a temperature quotient of Q_{10}, the frequency of nerve impulses in a single fiber is 10^{80}. When two balls of equal size differing minutely in temperature are presented to the snake, it will invariably and unhesitatingly strike at the warmer.

Certain insects have highly developed smell receptors. The antennae of male silk moths are highly sensitive to the odorous material produced by females of the same species, which they can detect at great distances. Hairs of various flies are amazingly sensitive to certain chemicals—some to salt, some to acid, some to alcohol. Spiders and some insects have mechanoreceptors by which they can detect minute vibrations, which they use for localization of prey or enemy. The lobster has a beautifully designed equilibrium sense organ which is sensitive to movement in various directions, to maintain position in one or another plane, and to vibration. The antennae of flies contain mechanoreceptors sensitive to a wide range of frequencies. This sensitivity permits analysis of each wing beat, with a delay of only 1 millisecond. The speed of flight is controlled by this sense organ. The flies long ago modified their back pair of wings into a vibrating gyroscope, which we are now trying to imitate.

The praying mantis integrates all the information it receives on the position of a fly, strikes and captures its prey —all within the space of 50 milliseconds. Bees use polarized light in returning to a source of nectar or to the hive. The visual accomplishments of certain birds are legendary; some use clicking sounds for echolocations. In the owl the shape of the head is related to a highly developed sound-locating system which enables the animal to pick up its prey in the dark. These examples could be multipled almost indefinitely.

Some animals have receptors and sense organs which have been described anatomically but whose function is still unknown. Other animals are able to perform amazing feats—notably, the long migratory trek of birds—by mechanisms which are completely unknown to us.

I plead for patience with the Air Force biologist when he uses strange specimens of animal life. The wisdom and wonder of animal life have long attracted man. Let me remind you of the comments of the prophet Agur:

> There be four things which are little upon the earth, but they are exceeding wise;
> The ants are a people not strong, yet they prepare their meat in the summer;
> The conies are but a feeble folk, yet make they their houses in the rocks;
> The locusts have no king, yet go they forth all of them by bands;
> The spider taketh hold with her hands, and is in kings' palaces (Proverbs 30: 24–28).

Note

1. I am indebted to Drs. H. E. Savely and H. Chinn of the Air Force Office of Scientific Research for many of the ideas expressed in this article.

Science in the News

Disarmament: A New Agency Is Organized To Coordinate Research and Planning of Policy

The State Department has quietly announced the organization of a United States Disarmament Administration, a move that reflects the increasing disposition to put more effort into the question of arms control and related problems than has been done in the past. But the importance and exact role of the new organization remains uncertain even to those within it, and will remain so until some time after the election.

As described by State Department spokesmen, the Disarmament Administration will be an interdepartmental agency headed by a presidential appointee holding a rank roughly equivalent to Under Secretary of State, that is, the rank immediately below cabinet status. Its chief will report to the Secretary of State. Its staff, as presently planned, will consist of about 40 state department officers and about an equal number of representatives of other government agencies, drawn principally from the Defense Department, and to a lesser extent from the Atomic Energy Commission, the United States Information Agency, and perhaps others. Additional technical and scientific personnel will be recruited from outside the government.

The agency is seen as a staff organization: that is, it will not make or carry out policy, but rather organize and supervise policy studies and technical research and formulate policy recommendations to be presented to the Secretary of State and through him to the National Security Council and the President. This organizational setup reflects the widely held feeling that the intimate connection between arms control policy and over-all defense and foreign policy would make an independent policy-making (rather than policy-planning) Disarmament Administration unworkable.

Senator Kennedy and other Democrats have been calling for establishing a research agency. Last winter Kennedy suggested the organization of an Arms Control Research Institute, an agency quite similar to the newly organized Disarmament Administration. Administration officials, though, say that the study which led to the formation of the new agency was initiated last fall, before the Kennedy proposal was made.

Types of Research

The research program the Disarmament Administration will sponsor, and in some cases, conduct, is like almost everything else about the agency, highly tentative. Now that policy planners have begun to think more seriously about arms control and about the broader question of policies to enhance international stability and lessen the likelihood of war, they have become sharply aware of the number of questions for which there is no well-based answer. There is no tradition of research in this area, or of large-scale federal support for research projects generally in the area of foreign affairs. Congress has been leery of providing funds and the Administration has not been very aggressive in asking for funds. Everyone agrees that the amount of money currently available for research ($400,000 for fiscal '61) is trivial compared with the needs of a large-scale program. (Although comparisons tend to be misleading, the $400,000 for research to be sponsored by the Disarmament Administration amounts to less than 0.01 percent of the money that will be spent this year on weapon research and less than 0.001 percent of over-all defense spending.) But the small amount of money available is not an immediate problem since it will probably be at least 6 months or more before the research program takes definite shape and the Disarmament Administration is ready to get a substantial program underway.

Military Studies

At the minimum the research program will have to cover the military and technical studies necessary to gauge the implications of any proposals we might like to make, or of proposals that may be offered by other nations. To cite obvious examples: proposals for a neutralized zone in Europe or elsewhere, or for reductions of the size of standing armies or for the abandonment of foreign bases all require studies of the probable effect of such agreements on our relative defensive strength vis-à-vis the communist powers. A few years ago a proposal for abandonment of bases would have clearly weakened America's military position far more than the Russian position. The Russians were not relying to any important extent on air bases outside their borders; we were relying very heavily on our overseas bases. The development of long-range missiles and bombers has changed the situation. Perhaps a proposal for abandoning some or all of our bases would be acceptable now. But without careful military studies our negotiators would not be sure of how much we are giving up, or of how important whatever concessions the Russians might offer would be. Uncertainty as to what we might be getting into would very likely by itself prevent an agreement from being reached.

Technical and Scientific Studies

Again, the need for a reasonable degree of certainty requires technical and scientific studies. Any agreement we might reach on underground nuclear testing would involve some risk. No inspection and enforcement system is going to be absolutely foolproof. Current American policy is that some degree of risk is acceptable in return for the advantages of a test-ban treaty. But fruitful negotiations are unlikely if the negotiators have almost no idea of how much risk of evasion is involved under a given inspection system. Technical and scientific research is necessary to provide a basis for negotiations, and more research is necessary to try to develop inspection devices and techniques that reduce the degree of risk to an acceptable level.

Along with the technical and military research, studies are needed of the nonmilitary implications of arms control policies. Chester Bowles, Senator Kennedy's closest adviser on foreign affairs, last week suggested that we probably should not agree to a reduction of the Western garrison in Berlin. He said we have 10,000 men there and that although it did not really make much

difference from a military standpoint whether we happened to have stationed 5000 men more or less in Berlin, that the 10,000-man garrison had become symbolic of American determination to stand by West Berlin, and, on a broader scale, Western Europe. He suggested that an agreement to reduce the size of our garrison in Berlin might impress Europe as somehow suggesting a lessening of our commitments in that part of the world. Thus a very modest proposal for arms reduction, involving no significant military concession, becomes quite involved when examined from a broader viewpoint. The importance of these broader aspects explains why virtually no one in a responsible position believes it is sensible to set up a disarmament policy-making agency that would operate independently of the State Department, and why representatives of the United States Information Agency, which is concerned with public opinion abroad, are being included in the new Disarmament Administration.

International Negotiations

The policy, technical, and military research suggested above constitutes about the minimum responsibilities of the new Disarmament Administration if it is going to be a meaningful agency. This work would include studies to determine what types of agreements would tend most strongly to lessen the chance of war, and what types of agreements, given the state of world affairs, can realistically be aimed at. In addition to sponsoring and coordinating such research, the agency will be expected to back up American negotiators, providing them with the specific information they might need on a day-to-day basis during an international conference.

A fair amount of work along these lines is already being done. A large program of research into means of detecting underground tests is being sponsored by the Defense Department. Problems such as the effects of our giving up our foreign bases are being worked on in the Defense and State Departments. The President's Science Advisory Board has been used to organize technical teams to supply information to backstop the negotiations at Geneva. But the new Disarmament Administration will serve to give a focal point to such work, and as a central agency for supporting additional work that is needed.

But any work in the field of disarmament tends to find itself involved very quickly in the larger problem of promoting international stability as part of the effort to avoid the outbreak of war. As noted here in a previous report (*Science* 29 July) a good deal, probably most, of the modest amount of "disarmament" research being conducted at universities and research institutes around the country is actually research into the problem of stability. Although such research has been increasing, there is a wide feeling that not enough is being done. There is no central organization to coordinate and keep track of the work that is being done, and no government agency responsible for supporting such research. At this early stage officials of the Disarmament Administration are not sure what the role of the new agency will be in this broader area.

There are limits to what an agency can usefully do. The proposal of the Democratic Advisory Committee for a National Peace Agency (as opposed to Kennedy's plan for an Arms Control Research Institute) commands little support in Washington. The Peace Agency proposal would have involved a very broad range of activities, including even such things as work on ways to build up and stabilize underdeveloped countries. Such activities are not unrelated to the problem of arms control, but they would clearly involve areas that are already the responsibility of existing agencies. The Democratic platform gave token support to the idea but downgraded the National Peace Agency into "a national peace agency," suggesting that what the platform writers had in mind was something less elaborate and closer to Kennedy's proposal. Nevertheless, it is likely that even with more limited aims the Disarmament Administration would find itself getting involved in some of the much broader questions, at least to the extent of bringing the problems into clearer focus, even if the actual work would be the responsibility of other agencies.

Coolidge Commission

A year ago the Coolidge Commission was organized to conduct a study of American disarmament activities. It submitted its report in January, but its recommendations conflicted with administration policy at several points and the report was never made public. In April, though, the Washington *Star* published a summary of the recommendations, apparently leaked by a Defense Department official sympathetic to the report's criticism.

The report suggested that major disarmament effort be postponed for several years, until after the country had developed a stronger deterrent force; that our ability to fight limited wars was inadequate and should be strengthened; and that the underground nuclear test ban was probably unwise because it would prevent us from developing improved tactical nuclear weapons. Thus the report was not only critical of the test-ban negotiations but of the equally touchy question of whether the Eisenhower administration was spending an adequate amount of money on defense. It demonstrated how inevitably a study of disarmament policy finds itself dealing with the broader question of stability, even to the extent of recommending more of certain types of armaments.

But despite its generally bearish outlook, the Coolidge report did recommend a number of positive steps. It endorsed the ban on nuclear testing above ground, a policy which is no longer a matter of dispute; it recommended agreeing to a ban on nuclear weapons in satellites; it suggested we might agree with the Russians on a demilitarized zone in Central Europe. But the report also involved itself in much broader questions of international stability: It recommended a UN police force; greater use of UN official observers at trouble points; strengthening of the World Court; and a commission to codify international law.

Other proposals frequently made in the same area have been for a treaty providing for the international control of space, Rockefeller's recommendation that the United States take the lead in encouraging the formation of regional groupings of nations, and DeGaulle's endorsement of a Western European parliament. All of these proposals to some extent are aimed at reducing the possible areas of international conflict, and it would be difficult for the Disarmament Administration to avoid taking an interest in them, although actual responsibility would be with other agencies.

International Stability

Another group of questions involves the effects of unilateral American policies on international stability: How, for example, can our defense effort and our deployment of forces be made to best assure the communist powers that

we are building an invulnerable retaliatory force without frightening them into thinking that we are planning to initiate a war?

There is the question of informal and sometimes tacit agreements we have reached with the Russians under which it is understood that neither side will do certain things, even though it may be impossible to make the same agreement through formal negotiations. Neither we nor the Russians are supplying atomic weapons to our allies. There is no spoken agreement, but if either broke the unspoken agreement the other would probably follow suit.

As announced by the State Department, the Disarmament Administration would have responsibilities only in the area of formal international agreements on arms control. But even more than with the efforts to promote stability through strengthening international organizations and international law it is probable that the Disarmament Administration would find itself involved in studies of possibilities for unilateral or informally agreed upon steps we might take to promote stability.

One of the reasons for the great emphasis on stability research under the name of disarmament is that no one is really counting on major disarmament agreements in the foreseeable future. The reluctance of the communist countries to open themselves to inspection is almost by itself an impassable wall at this stage. Thus almost anyone who starts to work on disarmament tends to find himself interested in broader aspects of stability which offer more promise of being able to actually get something done to reduce the risk of war.

Some progress has been made at the test ban negotiations, but the parallel 10-nation disarmament conference at Geneva never reached the stage of serious negotiations. No one expected much of the disarmament debate at the United Nations this week. The formation of the new Disarmament Administration reflects a feeling that we may be able to take some small steps rather than a wave of optimism that big things are about to happen. It reflects a step away from the long-held belief that arms control is an area that has to be given token support for the sake of world opinion to a belief that it is worth making a more serious and concerted effort to try to do something positive, aside from building a strong defense, to minimize the risk of war.

News Notes

First Group of Publications Translated Abroad Now Ready for Distribution

The first delivery of Russian scientific and technical publications translated abroad as part of a cooperative federal agency program has been announced by the National Science Foundation and the U.S. Department of Commerce. The program is financed by the overseas sale of surplus United States agricultural commodities. Countries that purchase this country's farm surpluses pay in local currency, which the United States may spend only in the country of purchase.

The translations were prepared by the Israel Program for Scientific Translations, Jerusalem, under contract with the National Science Foundation. Projects are now under way in Israel, Poland, and Yugoslavia to produce translations of 89,000 pages of scientific and technical material originally published in languages unfamiliar to most U.S. scientists.

Alan T. Waterman, NSF director, says, "The cooperation by participating scientists here and abroad—singly and in groups—has shown that the translation programs will have the important effect of stimulating expanded scientific information exchange without respect to national boundaries, and in recognition of true national scientific accomplishment. . . ."

In carrying out its functions under the program, the foundation assists participating government agencies in the selection of material to be translated. These agencies include the Departments of Agriculture, Interior, and Commerce; the Atomic Energy Commission; the National Library of Medicine of the Department of Health, Education, and Welfare; and the Smithsonian Institution. Final selection of material is made by government scientists on the basis of the needs of their agencies and the requirements of the scientific community. Lists submitted by agencies are checked by NSF for duplicate requests, and commercial publishers are consulted to determine their interest in the material recommended.

The Office of Technical Services of the U.S. Department of Commerce receives, catalogs, distributes, and sells the translations at approximately 1 cent a page. In cooperation with the Special

Officials responsible for the program examine the first Russian scientific and technical publications translated in Israel under a federal project financed by the overseas sale of surplus U.S. agricultural commodities. (Left to right) John Green, director, Office of Technical Services, U.S. Department of Commerce, the office which will distribute the translations; Ephrim Lahav, scientific counselor, Embassy of Israel; Avraham Harman, Israel's Ambassador to the United States; Burton W. Adkinson, National Science Foundation; and Alan T. Waterman, director, National Science Foundation.

Libraries Translations Center at John Crerar Library, Chicago, OTS issues a semimonthly publication, *Technical Translations*, to announce new translations available and in preparation. (The journal is sold on subscription by the Superintendent of Documents, Government Printing Office, Washington 25, D.C. $12 a year; $16 overseas.)

New Joint Board Will Coordinate Military and Civilian Space Work

The National Aeronautics and Space Administration and the Department of Defense have established a joint board, the Aeronautics and Astronautics Coordinating Board, to coordinate the nation's military and civilian space programs. For the past 8 months there has been no official body to coordinate the two programs, which between them are already spending more than $1 billion annually. The new unit will review planning to avoid duplication, coordinate activities of common interest, identify problems requiring solution, and insure a steady exchange of information.

The director of defense research and engineering and the deputy administrator of NASA will serve as co-chairmen. These positions are now held by Herbert F. York and Hugh L. Dryden, respectively.

Organization of the board includes a number of panels. These panels will identify and study problems related to space and aeronautics programs and make recommendations to the board for their solution. Panel chairmen are members of the board.

The Panels and Their Chairmen

Panels so far constituted and their chairmen are as follows: Launch Vehicles, Courtland D. Perkins, Assistant Secretary of the Air Force for Research and Development; Manned Space Flight, Abe Silverstein, director of Space Flight Programs, NASA; Space Flight Ground Environment, Donald N. Yates, deputy director of defense research and engineering; Unmanned Spacecraft, Homer E. Newell, deputy director of space flight programs, NASA; Supporting Space Research and Technology, Ira H. Abbott, director of advanced research programs, NASA; and Aeronautics, John T. Hayward, deputy chief of naval operations (development).

For the present, the area of life sciences is to be covered by the Manned Space Flight Panel. However, NASA and the Department of Defense have instituted action to establish a joint Life Sciences Committee to report to the board.

Membership of the board also includes two members-at-large to insure representation of all military departments and equal representation between the Department of Defense and NASA. These members and their alternates are Richard S. Morse, director of research and development, Department of the Army, and alternate A. G. Trudeau, chief of research and development, Army, and Robert C. Seamans, Jr., associate administrator of NASA, and an alternate to be appointed later.

The board, which meets at least bimonthly, has had two meetings.

Pauling Loses in Court of Appeals; Senate Committee Hearing Postponed

Nobel Prize-winning chemist Linus Pauling has failed in his attempt to have the U.S. Court of Appeals in Washington, D.C., invalidate a Senate Internal Security Subcommittee order that he provide the names of volunteers who helped him circulate a petition to end nuclear tests. The petition, which listed the signatures of 11,021 scientists in 49 countries, was submitted to the United Nations in 1958. Pauling holds that forcing him to disclose the names is a violation of his constitutional rights, and that his compliance with the subcommittee demand might well subject his co-petitioners to harassment and possible loss of their jobs.

A point raised in the government's argument was that the suit was unwarranted because the subcommittee members had asked only that Pauling "bring the names," and that they might not necessarily want to "see them."

The Appeals Court ruling, which followed similar action in August by the U.S. District Court, was handed down on 5 September. On 9 September, A. L. Wirin, Los Angeles Civil Liberties Union attorney who is representing Pauling, appealed to the Supreme Court, at the same time asking Chief Justice Earl Warren for a stay of the subcommittee hearing, scheduled for 15 September, until the Court can reach a decision after it reconvenes in October. The request for a stay was denied on 12 September, but the subcommittee had already announced that it would postpone its hearing until 11 October, the day after the Supreme Court opens its new session and a week after it reconvenes.

Model Atomic Laboratory To Be Exhibited in South America by AEC

The U.S. Atomic Energy Commission has shipped a major scientific exhibit to Buenos Aires, Argentina, for the first presentation of its South American tour. The exhibit is a complete, movable laboratory with technical facilities and equipment needed to present the peaceful atom at work in the fields of industry, medicine, and agriculture. Features include a low-power operating research and training reactor and an operating 2000-curie, cobalt-60 gamma-ray facility.

Initially, the unit will be displayed in conjunction with the Argentine Sesquicentennial Celebration in cooperation with the Argentine Atomic Energy Commission. The exhibit will open on 1 November and continue for 6 weeks in a new kind of building—a unique, transportable, air-supported structure designed especially for the South American tour. During 1961, the exhibit will be shown in Rio de Janeiro, Brazil, in March; in Caracas, Venezuela, in July; and in Lima, Peru, in October. Government officials and scientists from each country will cooperate with the AEC in presenting the display and in conducting scientific experiments.

News Briefs

Discoverer XV. The Air Force fired its 15th Discoverer satellite into orbit on 13 September from Vandenberg Air Force Base, Calif. However, the recovery attempt the following day failed. Although the 300-pound space capsule was sighted floating in the sea near Christmas Island, some 1000 miles from its expected area of descent north of Hawaii, it sank before it could be retrieved. The two previous Discoverer payloads, launched in August, were successfully recovered, one from the sea and one from the air.

* * *

Information center survey. All United States scientific and technical information centers are asked to cooperate in a survey being conducted by Battelle Memorial Institute for the National Science Foundation. The survey is in-

tended to locate all information centers in the United States serving the physical and life sciences and technologies and to collect factual data relating to their activities and services.

Completed questionnaires will be used to prepare a national directory and to relate the activities of the centers to the total U.S. scientific and technical information program. Any activity which identifies itself as an information center should send its name and address to Mr. William H. Bickley, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio.

* * *

Bartlett memorial fund. A Bartlett Memorial Exploration Fund has been created by friends and former students of the late Professor Harley H. Bartlett, who was director of the Botanical Gardens at the University of Michigan. The fund, independent of another Bartlett fund administered by the botany department at Michigan, will be used to support field work of students and mature workers in anthropology, linguistics, and other disciplines as well as in biology, in keeping with Bartlett's own wide-ranging interests in explorations. Contributions should be addressed to the Institute for Regional Exploration, P.O. Box 1172, Ann Arbor, Mich.

* * *

Pavlovian conference. The Pavlovian Conference on Higher Nervous Activity, sponsored jointly by the New York Academy of Sciences and the Academy of Medical Sciences of the Union of Soviet Socialist Republics, will be held at Town Hall in New York, 13–15 October. Seven outstanding Soviet psychophysiologists and 31 United States scientists will participate in the conference. The Soviet visitors are S. A. Sarkisov, P. K. Anokhin, P. S. Kupalov, V. V. Zakusov, V. G. Rusinov, A. V. Snezhnevsky, and E. A. Asratyan.

* * *

Middle East science. The third annual Conference on Science and Technology in Israel and the Middle East will be held 15–16 October at the Hotel Astor in New York under the auspices of the American Technion Society. Some 400 participants will hear reports on scientific achievements and technological advances of particular interest to countries in the Middle East. Proceedings of the conference will be available to interested governments and organizations in all countries of the Middle East. The American Technion Society (1000 5th Ave., New York) is a nation-wide group of scientists, engineers, educators, and industrialists that provides financial and technical assistance to the Technion-Israel Institute of Technology, the only technological institution of higher learning in Israel.

* * *

New book publisher. A new science book publishing house, W. A. Benjamin, Inc., has been founded in New York. William A. Benjamin, president of the firm, is a former McGraw-Hill editor. The company's publication plans include a series of science text and reference books for college students, as well as a series of paperback monographs designed to supplement existing textbooks. Initially the company is specializing in the related fields of chemistry and physics, and its first books are scheduled for publication during 1961. The board of directors includes Konrad E. Bloch of Harvard University, Donald F. Hornig of Princeton University, and John D. Roberts of California Institute of Technology.

* * *

Zoological nomenclature. The International Commission on Zoological Nomenclature has given notice of the possible use of its plenary powers in connection with 14 cases of nomenclature, full details of which will be found in the 16 September *Bulletin of Zoological Nomenclature* (vol. 17, pts. 9 to 11). Any zoologist who wishes to comment on any of the cases should do so in writing, and in duplicate, as soon as possible, and in any case before 16 December. All communications should be addressed to: The Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W.7, England.

* * *

Atomic document guide. The United Kingdom Atomic Energy Authority has published a revised edition of its *Guide to U.K.A.E.A. Documents*. The first edition, issued in 1958, was quickly exhausted, and it has been out of print for some time. Copies of the publication may be purchased from British Information Services (Sales Section), 45 Rockefeller Plaza, New York 20, N.Y., for 32 cents postpaid.

* * *

Cost of high-energy physics. In 10 years the government's yearly expenditure for high-energy physics has increased 500 percent, according to John A. McCone, chairman of the Atomic Energy Commission.

Scientists in the News

John A. McCone, chairman of the Atomic Energy Commission, is heading the United States delegation to the general conference of the International Atomic Energy Agency in Vienna. The 2-week conference, which began on 20 September, is the fourth annual meeting of the 79-member agency and is probably the most critical, partly because of the current strain in East-West relations. However, although Stalinist Vyacheslav M. Molotov has recently been appointed permanent Soviet representative to the agency, the Soviet delegation is headed once again by Vasily S. Yemelyanov, director of the State Committee for Peaceful Uses of Atomic Energy and a consistent supporter of IAEA.

Tracy M. Sonneborn, distinguished service professor of zoology at Indiana University, was elected president of the American Institute of Biological Sciences at the annual meeting of the governing board in Stillwater, Okla., on 27 August. He will take office on 1 January, succeeding **James G. Dickson**.

Bernard S. Meyer, professor of plant physiology at Ohio State University, was named vice president, and **F. P. Cullinan** was re-elected secretary-treasurer. **George Beadle**, Nobel Prize-winning chairman of the department of biology at California Institute of Technology and former AAAS president, was named an honorary adviser of the governing board, a newly created position.

Washington University, St. Louis, has announced several appointments.

Kurt Hirsch, reader in mathematics and professor of pure mathematics at the University of London, has been appointed visiting professor of mathematics.

Edwin T. Jaynes of Stanford University has been appointed associate professor of physics.

Guido L. Weiss of De Paul University has been appointed associate professor of mathematics. However, he will be on leave this year to conduct research in France as a National Science Foundation fellow.

Two other faculty members received leaves of absence for the 1960–61 academic year.

Allen Devinatz, associate professor of mathematics, has been awarded a National Science Foundation senior postdoctoral fellowship for research at the

Institute for Advanced Study, Princeton, N.J.

Isidore I. Hirschman, Jr., professor of mathematics, will conduct research in Zurich, Switzerland, under a contract with the U.S. Air Force.

Neal Miller of Yale University became the president of the American Psychological Association on 8 September as the association's 68th annual meeting came to a close in Chicago. He succeeded **Donald O. Hebb** of McGill University, Montreal, who is now a member of the association's board of directors.

Walter M. Elsasser, professor of theoretical physics at the University of California, La Jolla, has been appointed professor and chairman of the department of physics at the University of New Mexico.

David S. Anthony has been appointed a principal scientist with the University Relations Division of the Oak Ridge Institute of Nuclear Studies. Anthony is an associate professor of chemistry at the University of Florida and has taken a 1-year leave of absence to join the ORINS staff.

Charles A. Whitten of the U.S. Coast and Geodetic Survey was elected president of the International Association of Geodesy at the 12th General Assembly of the International Union of Geodesy and Geophysics held recently in Helsinki. The association is one of the seven that make up the International Union of Geodesy and Geophysics.

Albert E. Sobel, head of the department of biochemistry at the Jewish Hospital of Brooklyn, received the Ames Award in Clinical Chemistry on 30 August at a joint meeting of the Canadian and American Societies of Clinical Chemists. The award is a national one, given annually by the American Association of Clinical Chemists. Sobel's contributions include new methods of ultramicroanalysis and development of a theory on the mechanism of bone formation.

The General Electric Company's Hanford Laboratories Operation in Richland, Wash., has announced the following staff changes.

During the coming year, **R. L. Uhler** will work in the Radiobiological Laboratory of the Agricultural Research Council in England, with **R. Scott Russell**. In exchange, **D. A. Barber** of the English laboratory will be at Hanford this year. Both are investigating the uptake of fission products by plants.

J. F. Cline has obtained a 1-year leave from Hanford to accept an appointment with the International Atomic Energy Agency as technical adviser to the Tunisian Government on uses of radio-isotopes in agriculture. **H. V. Koontz** has accepted a temporary appointment with the Hanford laboratory to replace Cline during his absence.

Lawrence J. Heidt of the chemistry faculty at Massachusetts Institute of Technology has been appointed Visiting University Professor of Boston College. He will give a series of 20 lectures during 1960–61 on his research in physical chemistry. He is best known for his work on photochemical problems.

H. M. A. El-Sum, formerly senior research scientist in physics at the Lockheed Missiles and Space Division, Palo Alto, Calif., has a new position with the General Electric Computer Laboratory in Palo Alto, where he is in charge of electromagnetic-optics research and development activities.

Everett F. Davis, formerly a staff member of the National Institute of Arthritis and Metabolic Diseases, has been appointed executive secretary in the fellowships section of the Research Training Branch, Division of General Medical Sciences, National Institutes of Health.

Isaac Neuwirth, formerly professor and chairman of the department of pharmacology at New York University College of Dentistry, has been appointed visiting professor in the department of biochemistry at New York Medical College.

Edward M. Weyer, Jr., has been appointed director of the School of American Research in Santa Fe, N.M. Weyer, an anthropologist, was formerly in charge of the Museum of Anthropology at the University of California in Berkeley and prior to that was for many years at the American Museum of Natural History, where he served as editor of *Natural History* magazine.

L. N. Recktenwald, formerly of Villanova University, has been appointed associate professor in the department of psychology and education at the University of Scranton.

W. Keith Boyd has been appointed technical director of the U.S. Army Snow Ice and Permafrost Research Establishment, Wilmette, Ill. He has served as chief of SIPRE's applied research branch since 1953.

Recent Deaths

Alan Brown, Toronto, Canada; 73; one of Canada's best-known pediatricians and a professor of pediatrics at the University of Toronto; retired in 1950 as physician in chief of the Hospital for Sick Children after 32 years in that post, during which time he worked without salary, maintaining his family through his private practice; in 1930, with Frederick Tisdall and T. G. H. Drake, he developed the formula for the precooked cereal known as Pablum, from which the three doctors received no profit because they granted the hospital the manufacturing royalties; 7 Sept.

Sir **Harold D. Gillies**, London, England; 78; pioneering plastic surgeon in Britain, who aided thousands of wounded service men in both world wars; with Ralph Millard, wrote *The Principles and Art of Plastic Surgery*, published in 1957; 10 Sept.

Thurlow Nelson, Cape May Courthouse, N.J.; 69; marine biologist noted for his research in shellfish culture; retired in 1956 from Rutgers University, where he had headed the department of zoology since 1925; currently was Julius Nelson professor of zoology in the Rutgers Graduate School, occupying the chair founded in memory of his father; was attached to the research staffs of the Marine Biological Laboratory at Plymouth, England, the London School of Tropical Medicine, and the Molteno Institute for Research in Parasitology at Cambridge University; 12 Sept.

Mahlon F. Peck, Westminster, Md.; 47; professor in the physics and mathematics department of Western Maryland College for 13 years; 12 Sept.

Arthur C. Willard, Urbana, Ill.; 82; president emeritus of the University of Illinois and a well-known mechanical engineer, who had been acting dean of the university's College of Engineering; 12 Sept.

Thomas Woody, Philadelphia, Pa.; 68; professor of education at the University of Pennsylvania, known for his research and writings in the fields of comparative education and the history of education; had been a member of the Pennsylvania faculty for 41 years; 11 Sept.

Book Reviews

Die Evolution der Angiospermen. Armen L. Takhtajian. Translated from the Russian by W. Höppner. G. Fischer, Jena, 1959. viii + 344 pp. Illus.

Origins of Angiospermous Plants. Armen L. Takhtajian. Translated by Olga Hess Gankin. G. Ledyard Stebbins, Ed. American Institute of Biological Sciences, Washington, D.C., 1958. 68 pp. U.S., $3; foreign, $3.50.

Essays on the Evolutionary Morphology of Plants. Armen L. Takhtajian. Translated by Olga Hess Gankin. G. Ledyard Stebbins, Ed. American Institute of Biological Sciences, Washington, D.C., 1959. 139 pp. U.S., $5; foreign, $5.50.

From these three publications which have recently become available either in German or in English, it is apparent that Armen Takhtajian has been more successful than anyone else to date in putting together a connected and plausible account of the origin and morphological evolution of flowering plants. (Axelrod's recent admirable essay, "The evolution of flowering plants," is concerned primarily with paleontological, geological, geographical, climatic, and ecological considerations, rather than detailed structural considerations.)

In *Die Evolution*, another tribute to the Darwinian centennial year, Takhtajian has attempted to winnow from a very extensive array of modern morphological studies all available evidence bearing on the phylogeny of angiosperms. He concludes that the group was derived monophyletically from extinct gymnospermous stock arising between seed ferns and Bennettitales, probably in small montane populations during early Jurassic or even late Triassic time. Within angiosperms, the primitive forms were sympodially branched evergreen trees possessing unspecialized vascular tissues and bearing simple, more or less entire, stipulate, open pinnately veined leaves, with three or more traces and leaf gaps. He visualizes the flower as a bisporangiate strobilus, now best represented by a magnolian flower, which has undergone those evolutionary modifications familiar to students of the ideas of Arber and Parkin, Bessey, Hallier, and Hutchinson. The stamens and carpels are interpreted as the classical phyllome structures formed by reduction of the leafy sporophylls of their gymnospermous forebears. Insect pollination is held to be the principal motivating and guiding force in the development and modification of flowers, which he believes to be primitively cross-pollinated; "simple," unisporangiate, and "naked" flowers are regarded as invariably derived in response to a change to anemophily. He finds evolutionary trends also in spores and gametophytes. "Double fertilization" is a necessary concomitant of the extreme reduction of the megagametophyte, permitting the quick production of a compensatory food supply. In the seed he regards a nuclear endosperm as primitive and the loss of a sarcotesta and the development of arillar structures as derived. He devises his own evolutionary classification of fruits, dividing them into apocarpous versus coenocarpous types of different placentation, and stressing the nature of the floral gynoecium to the subordination of superficial adaptive features.

Major changes, such as the formation of a flower from a gymnospermous strobilus, a carpel from a compound megasporophyll, a truly monocotyledonous embryo from a dicotyledonous one, or the production of gametangium-less gametophytes, Takhtajian attributes to major changes in ontogenetic development, which may lead to the fixation of widely different adult conditions.

The last third of the book presents a descriptive "system" of angiosperm families arranged in 18 "super-orders" and 82 orders. This is illustrated by a rather shrubby phylogenetic tree, which begins with Magnoliales and has such prominent secondary key loci as Liliales for monocotyledons, Dilleniales, Hamamelidales, Theales, Cistales, and Cuno-niales. Takhtajian stresses that "Evolutionary morphology is accordingly the foundation pillar of the modern mega-taxonomy of plants" and emphasizes that correlating as wide a spectrum of characters as possible is the only feasible way to determine relationship. He also remarks of taxonomy: "among many biologists of experimental aim the notion is widespread that Systematics is a branch of knowledge that is absolutely outmoded. This conception of Systematics is profoundly false and the resule of a certain narrow-mindedness of thought associated with one-sided specialization. . . . The fundamental general-biological significance of Systematics consists in that millions of facts that have no sort of scientific value in themselves find their place in the constructions of Systematics. Systematics is consequently not only the basis of biology, but also its coronation."

While the great value of this book to Western workers is, of course, in the wealth of unfamiliar Russian literature Takhtajian brings to our attention in this and the following works, it is interesting to note that the extensive bibliography has more than 750 references to papers and books in English, many of them of quite recent date.

The *Origins* is pretty much a condensed and somewhat popularized version of the ideas and conclusions just enumerated, with stress on the role of flowering plants in the earth's past and present vegetation, their origin and rapid elaboration, the primitiveness of Magnolian (Ranalian) types, and the derived nature of "Amentiferae" and monocotyledons. An appendix contains a synopsis of the proposed taxonomic system. The familiar Western literature has been edited out of the bibliography in both this and the following translation.

The *Essays* deals with more basic and theoretical considerations of evolution in all groups of plants, although emphasis is placed on vascular ones. The first 30 pages are devoted to a historical synopsis of plant morphology, ranging from Theophrastus and Goethe, whom the author greatly admires, to Zimmermann and the telome theory, and including a number of less familiar Russian authors. The second chapter (which also forms the introduction to *Die Evolution*) treats the interconnected forms of adaptive evolution: *progressive*—major advances in structural-functional organization; *specialization*—adaptive radiation; and *regressive*—secondary simplification. The confusing heterochrony of

evolutionary change in different organs, which is stated to be most pronounced in less specialized forms, is treated next. The bulk of the volume, however, is devoted to the major role in plant evolution attributed by Takhtajian to ontogeny and its modification, and to the related topics of recapitulation and "evolutionary teratology." "In evolution, new characteristics arise as hereditary alterations of organs at the most diverse stages of their morphogenesis, beginning with the formation of primordia and ending with the last developmental phases." This fact, according to the author, refutes Haeckel's famed biogenetic law, which postulates a recapitulation of ancestral *adult* forms. The principle of alteration of ontogenies is applied by Takhtajian to bridge a wide range of apparently profound gaps between major groups of plants and to explain the rise of new developmental lines differing sharply in adult form from their ancestors. At the same time, he cautions that the ontogenetic method must be used cautiously and in conjunction with comparative morphology, lest its potentialities be exaggerated as, for example, he believes they have been by Gregoire, Thompson, and others in denying the foliar nature of carpels. He concludes: "The evolutionary botany of the future will be erected on the basis of a synthesis of morphology and physiology."

If in all this there is very little that is startlingly new to Western students of plant evolution, it is interesting to discover that the climate of opinion is not radically different between East and West.

LINCOLN CONSTANCE
Department of Botany,
University of California, Berkeley

Metropolis and Region. Otis Dudley Duncan, W. Richard Scott, Stanley Liberson, Beverly Duncan, Hal H. Winsborough. Published for Resources for the Future, Inc., by Johns Hopkins Press, Baltimore, Md., 1960. xviii + 587 pp. $8.50.

The program which resulted, among other things, in this hefty volume was initiated by the Social Science Research Committee of the University of Chicago. It was largely carried on at the Population Research and Training Center of that institution, with support from the Ford Foundation and from Resources for the Future, Inc. (which also sponsored this volume). It is, according to the senior author, virtually a companion to the Resources for the Future study *Regional Economic Growth in the United States* by Harvey S. Perloff and others. Perloff is credited with being "in large measure responsible" for "the ideas which ultimately crystallized in this study."

The authors attempt an integrated treatment of the orientation of metropolitan structure in the United States, a study frankly cross-sectional, one providing a bench mark for dynamic analysis of future change. Its aim is threefold: (i) to review ideas on the nature of the metropolis, (ii) to test these ideas against an outline of the structural characteristics of the metropolitan economy of the United States about 1950, and (iii) to survey the industrial composition and regional relationships of the larger U.S. cities.

In analyzing metropolis structure the authors emphasize location and function. Influenced by Gras, they think of "the metropolis as an industrially developed city, strategically located at a focus of a transportation network." Such concepts are tested with statistical data on the 56 SMA's (SMA: Standard Metropolitan Area) with a population of 300,000 or more in the 1950 census.

Data on manufacturing industries are broken down into categories (i) according to the extent that raw materials are processed or materials already processed are fabricated, (ii) according to whether their output is for final or nonfinal markets.

With the aid of an ingenious diagram (Fig. 15, page 264) that plots commercial against manufacturing activity, the 56 cities are divided into seven categories: national metropolis, regional metropolis, regional capital, submetropolitan (diversified manufacturing with metropolitan functions), diversified manufacturing with few metropolitan functions, specialized manufacturing, and special cases. The authors are less interested in getting each city into a proper pigeonhole than in establishing a typological classification demonstrating how U.S. cities are differentiated in metropolitan functions and regional relationships.

The remaining half of the book is given over to data, discussions, and summaries for 51 of the cities. (The five national metropolises are omitted because their analysis would have overtaxed the available resources.) A detailed "industrial profile" is presented for each. The extent to which each industrial category has inputs and outputs that are local, regional, or national is discussed in considerable detail and summarized in tabular form. The salient facts for each city are presented in brief summaries. The Denver summary, for example, reads as follows: "Denver appears to be chiefly a commercial and financial SMA performing metropolitan functions for a large portion of the Mountain States. Some processing of resources is carried on—notably meat packing and sugar refining—and inputs appear to arrive from the immediate hinterland (Area B) in the case of sugar beets and from both hinterland and regional areas (B and C) for livestock. Transportation, wholesaling, irrigation, administrative, and educational services appear to be performed for a large but sparsely populated area (Area B) consisting chiefly of Colorado and parts of New Mexico and Wyoming, while financial, military and tourist functions are performed for a regional or national area" (page 380).

Stylistically the book tends toward a dull, polysyllabic, professional mumble. The following sentence is characteristic: "If we are right in thinking that times are ripening for the appearance of such a signal contribution to the theory of metropolitan structure, then our rather eclectic adaptation of a number of perspectives and analytical techniques may be excused as an effort to temporize with competing claims that we cannot adjudicate satisfactorily" (page 19). Resources for the Future should somehow induce a more straightforward expository prose in its reports.

EDGAR ANDERSON
Missouri Botanical Garden,
St. Louis, Missouri

Birds of Anaktuvuk Pass, Kobuk, and Old Crow. A study in arctic adaptation. United States National Museum, Bulletin 217. Laurence Irving. Smithsonian Institution, Washington, D.C., 1960 (order from Supt. of Documents, GPO, Washington 25). viii + 409 pp. Paper, $2.

Anaktuvuk Pass, an area of mountain tundra at an elevation of about 2400 feet, is important ornithologically because many species of birds use it in migrating through the formidable Brooks Range to and from the Arctic slope of Alaska. Kobuk, a village in the northwestern interior of Alaska, is on the Kobuk River about 120 miles from

the river's mouth. Old Crow, a village on the Porcupine River in northwestern Yukon Territory, is not far from McDougall Pass (elevation 1200 feet) through the Richardson Mountains, a pass "shorter and . . . lower than any . . . through the western mountains of America"; Old Crow is also not far south of the "northernmost . . . timber in America." Chapters 2, 3, and 4 are annotated lists of the birds found at these three localities, all of which are north of the Arctic Circle in what the author regards as "a well characterized faunal region." The list for Old Crow is surprisingly short on sandpipers, only nine species having been found there, in contrast to 16 species at Kobuk and 18 at Anaktuvuk. The author considers Porcupine Valley "an unimportant migratory path" for shore birds. Virtually all migration observed in this valley in the spring of 1957 moved in an easterly direction.

The three chapters just mentioned are not ordinary annotated lists. References to the Eskimos and Indians are unfailingly interesting. Of the Alaskan (Eskimo) and Yukon (Old Crow Indian) names for the many birds common to the two regions, those for only two species resemble each other at all closely—the onomatopoeic *Ahalik* (Eskimo) and *Ahaluk* (Indian) for the old squaw duck, and the *Nattak* (Eskimo) and *Nastok* (Indian) for the great gray owl. I am not sure that the "resemblance" of the latter two names is real. I cannot, incidentally, account for the absence of the snowy owl from the Kobuk list; the species certainly occurs there, as is evident from the status list on page 247.

Irving is primarily a physiologist. Yet in his first chapter, "The Background," he makes a statement of profound import to taxonomists: "Winter in the Arctic is so much colder than the freezing temperatures at which vital processes slow down to unproductive levels that it is, in a way, surprising to find there many animals and plants which indicate their long arctic establishment by having evolved special arctic forms. On the other hand, it is even more surprising that some arctic species are scarcely distinguishable from closely related populations living in warmer climates." Notable, too, are some of his taxonomic discussions, for example, that dealing with the white-winged scoter (*Melanitta deglandi*), the only species of North American migratory duck "distinguished into eastern and western races." The author's measurements of bills of dried specimens convinced him that eastern birds were not distinguishable from western; while admitting that eastern and western *wintering* populations are discrete, he believes that eastern and western birds mingle before and after nesting with the result that both the wintering and the nesting populations are "genetically mixed."

Basing many of his ideas directly upon findings reported in the annotated lists, Irving proceeds with chapters titled "Status and distribution," "Migrations and origins," "Residence in the Arctic," "Biological aspects of migration and nesting," and "Arctic metabolic economy of warm-blooded animals," gradually focusing less upon Alaska as a faunal region, more upon the problems of living anywhere in the Arctic. The concept of comfort, of well-being, of contentment (admittedly my own somewhat subjective word) runs through even the most abstruse parts of these chapters. This, to my way of thinking, is wholly justifiable. There is, of course, such a thing as being miserable in the cold. Ludwig Kumlien, in his account of the bird life of Cumberland Sound, Baffin Island, tells of the death of large numbers of small birds during a spring storm. A vast amount of writing capitalizes on the idea of being miserable in the Arctic. Yet every careful observer of life in the far north feels in his bones the exhuberance that is part of the long summer days, the swift shifting of the seasons, the brilliance of clear weather in winter, even in what is so often referred to as the "long winter night."

Among the most graphic and thought-provoking paragraphs in the book are those in Chapter 7. Writing of the springtime return to the breeding grounds, Irving says: "The birds arrive in an arctic season changing at a rate which cannot be imagined from experience confined to temperate regions. Daylight becomes continuous in May. In that month, from levels lower than those of the coldest part of winter in temperate regions, the arctic temperature rises to the warmth of summer. The water in the environment changes its physical state from snow and ice to liquid. But in any one year these day to day changes are not orderly, for until early June pleasant warmth, snowfall and bitter cold can succeed each other within a few hours. In these vagaries of the arctic weather . . . the birds arrive, settle, and proceed to nest with such regularity that their behavior sets the steadiest schedule among the natural phenomena."

Resident (that is, nonmigratory) birds of the far north adapt themselves to a warming of the air as spring advances; migrating birds, on the other hand, must adjust to increased chilling as they move northward. A given day may be warmer than the preceding to the resident form, much colder to the migrant form, yet both take the change in their stride—evidence of their ability to use such thermoregulators as feathers. It is known that arctic warm-blooded animals can keep their bodies some 80° warmer than the air by production of metabolic heat and by conservation of heat through natural insulation. Irving and his associates have ascertained that in winter "at −45°C and in warm summer the mean body temperature of 15 arctic and subarctic resident species of birds averaged 41.3°C." Mean body temperature among these species differ to about the same degree as those among birds in temperate regions. "Body temperatures of homoiothermic species are phylogenetically differentiated, but the differentiation shows no common regard for geographical range, and their temperatures are more stable than the climates of the earth, which have changed appreciably, while the temperatures of the birds that inhabit them apparently have remained fixed."

This is a sample. The discussions of critical temperature, of the stability of the basal metabolic rate, of variability in insulation, of heat loss through the extremities, and notably of the reproductive success of birds, despite the brevity of the arctic summer, make this volume invaluable to ornithologist and physiologist alike.

GEORGE MIKSCH SUTTON
Department of Zoology, University of Oklahoma

Plant Pathology. An advanced treatise. vol. 3, *The Diseased Population*. J. G. Horsfall and A. E. Dimond, Eds. Academic Press, New York, 1960. xiii + 675 pp. Illus. $22.

In contrast with the two previous volumes which treat the diseased plant and the pathogen as individuals, the present and concluding volume of this series deals with populations of plants in relation to diseases and their control. It gives detailed consideration to the vital concept of inoculum potential de-

fined as "the number of infective particles present in the environment of the uninfected host." On the intensity of this factor depends the frequency of infection and the severity of the resulting disease occurrence.

Following the usual introductory chapter in which the editors outline the theme of the volume, S. D. Garrett presents a well worked out chapter on the mechanism of the inoculum potential and the importance of the living host plant as an inoculating agent. The dispersal of inoculum, including fungi, bacteria, and viruses, is considered at length in chapters written by recognized specialists; the following topics are discussed: autonomous dispersal; dispersal of inoculum by insects and other animals; and dispersal by air and water, including the "take-off" and the "flight and landing" of infective material.

J. E. van der Plank contributes a chapter on the analysis of epidemics, and Paul E. Waggoner discusses that intriguing topic, the forecasting of plant epidemics, a subject much in the limelight of current phytopathological activity. Quarantines are considered by Ernst Gram with a thought-provoking evaluation of the plant quarantine system.

Finally, there is a series of chapters on certain general methods of controlling or preventing plant diseases from the points of view of cultural practices in disease control, soil treatment, performance of fungicides, and biological interference with epidemics. Stakman and Christensen conclude the volume with a detailed account of the past, present, and future of the problem of breeding disease-resistant varieties.

The editors and their collaborators have succeeded admirably in bringing together available information in the field of plant pathology, with special reference to modern trends.

JOHN A. STEVENSON
4113 Emery Place, NW, Washington, D.C.

Information and Decision Processes. Robert E. Machol, Ed. McGraw-Hill, New York, 1960. ix + 185 pp. Illus. $5.95.

This is a collection of papers presented at a symposium held at Purdue University in 1959. The papers range from informal and easily readable accounts of recent research to highly technical accounts. In the former category are papers by Brown and Doob on the role of computation in decision problems and the consistency of stochastic models. In the latter category is a résumé of recent work on Markov chains by Rosenblatt and on the lower bounds for the expected sample size of a sequential test by Hoeffding. There are also papers on information theory, subjective probability, and testing methods.

On the whole this is an interesting collection, but the small print renders the book almost unreadable.

GEORGE WEISS
Institute for Fluid Dynamics and Applied Mathematics, University of Maryland

New Books

Biological and Medical Sciences

Beecher, Henry K., Ed. *Disease and the Advancement of Basic Science.* Harvard Univ. Press, Cambridge, Mass., 1960. 427 pp. $12.50. The purpose of this volume, which developed out of the Lowell lectures of 1958, is to show that some kinds of fundamental advances in science can be made only from study of disease. Among the 21 contributors who discuss this proposition from the vantage points of their own knowledge and work are Paul Weiss, C. F. Cori, Ralph W. Gerard, and René J. Dubos.

Breckenridge, Marian E., and E. Lee Vincent. *Child Development.* Saunders, Philadelphia, Pa., ed. 4, 1960. 661 pp.

Compendium of Plant Diseases. Rohm and Haas, Philadelphia, Pa., 1960. 264 pp. A collection of colored illustrations showing diseased plants.

Heftmann, Erich, and Erich Mosettig. *Biochemistry of Steroids.* Reinhold, New York; Chapman and Hall, London, 1960. 242 pp. Text, $5.75; trade, $6.90.

Heller, John H., Ed. *Reticuloendothelial Structure and Function.* Ronald, New York, 1960. 483 pp. $12. Contains the papers presented at the 3rd International Symposium of the International Society for Research on the Reticuloendothelial System held in Rapallo, Italy, in August 1958.

Kalmus, H., and S. J. Hubbard. *The Chemical Senses in Health and Disease.* Thomas, Springfield, Ill., 1960. 102 pp. $3.75.

Lewis, Lena A. *Electrophoresis in Physiology.* With a chapter on "Immunoelectrophoresis" by M. D. Poulik. Thomas, Springfield, Ill., ed. 2, 1960. 120 pp. $5.50.

Mallette, M. Frank, Paul M. Althouse, and Carl O. Clagett. *Biochemistry of Plants and Animals.* Wiley, New York, 1960. 565 pp. $8.50.

Schade, Rudolf Otto Karl. *Gastric Cytology.* Arnold, London; Williams and Wilkins, Baltimore, Md., 1960. 89 pp. $8.

Schudel, Lydia. *Manual of Blood Morphology.* Lippincott, Philadelphia, Pa., ed. 9, 1960. 53 pp. $4.50.

Simon, Harold J. *Attenuated Infection.* The germ theory in contemporary perspective. Lippincott, Philadelphia, Pa., 1960. 365 pp. $10.

Skutch, Alexander F. *Life Histories of Central American Birds.* vol. 2, *Families Vireonidae, Sylviidae, Turdidae, Troglodytidae, Paridae, Corvidae, Hirundinidae, and Tyrannidae.* Cooper Ornithological Society, Berkeley, Calif., 1960.

Symposium der Deutschen Arbeitsgemeinschaft für Neuropsychopharmakologie. vol. 2, No. 2, of *Medicina Experimentalis.* Karger, Basel, Switzerland, 1960 (order from A. J. Phiebig, P.O. Box 352, White Plains, N.Y.). 238 pp. $9.50.

Unbreit, Wayne W. *Advances in Applied Microbiology.* vol. 2. Academic Press, New York, 1960. 396 pp. $12.

Watson, J. M. *Medical Helminthology.* Bailliere, Tindall and Cox, London; Williams and Wilkins, Baltimore, Md., 1960. 498 pp. $15.50.

Whitfield, I. C. *An Introduction to Electronics for Physiological Workers.* Macmillan, London; St. Martin's Press, New York, ed. 2, 1960. 274 pp.

Wiedling, Sten. *Xylocaine.* The pharmacological basis of its clinical use. Almquist and Wiksell, Stockholm, Sweden, 1960. 146 pp. Kr. 20.

Willmer, E. N. *Cytology and Evolution.* Academic Press, New York, 1960. 440 pp. $10.

Woolmer, Ronald F., Ed. *A Symposium on pH and Blood Gas Measurement.* Methods and interpretation. Little, Brown, Boston, 1959. Contains the report (10 papers) of the symposium held 2–3 December 1958; 25 participants attended the conference.

Zeisler, Ernest Bloomfield. *Electrocardiography: Principles and Practice.* Login Brothers, Chicago, Ill., 1960. 374 pp.

Zinseer: Microbiology. David T. Smith *et al.* Appleton-Century-Crofts, New York, ed. 12, 1960. 1040 pp.

Reprints

Bartlett, M. S. *An Introduction to Stochastic Processes.* With special reference to methods and applications. Cambridge Univ. Press, New York, 1960. 321 pp. $2.95.

Coxeter, H. S. M. *The Real Projective Plane.* Cambridge Univ. Press, New York, ed. 2, 1960. 226 pp. $3.75.

Graham, L. A. *Ingenious Mathematical Problems and Methods.* Dover, New York, 1960. 244 pp. Paper, $1.45.

Landau, Edmund. *Grundlagen der Analysis* (Das Rechnen mit Ganzen, Rationalen, Irrationalen, Komplexen Zahlen). Chelsea, New York, ed. 3, 1960. $1.95. In this edition the prefaces have been translated by F. Steinhardt and a German-English vocabulary has been appended.

Rawcliffe, D. H. *Illusions and Delusions of the Supernatural and the Occult.* Dover, New York, 1959. 551 pp. $2. Originally published as *The Psychology of the Occult.*

Thiel, Rudolf. *And There Was Light.* The discovery of the universe. Translated from the German by Richard and Clara Winston. New American Library, New York, 1960. 384 pp. $0.75.

Reports

Relationship between Feeding and Satiation Centers of the Hypothalamus

Abstract. Electrodes were implanted in the hypothalamus of five goats in which an alimentary instrumental conditioned reflex had been previously established. Electrical stimulation of the ventromedial hypothalamus inhibited the conditioned movements and food intake in hungry goats. This also occurred in those satiated goats in which eating and conditioned movements were elicited by stimulation of the lateral hypothalamic area. Withdrawal of the stimulation of the medial hypothalamus evoked a short aftereffect in the form of a recovery or increase in the trained movements and food intake.

It is known that two hypothalamic centers are involved in the regulation of food intake. These are: the lateral hypothalamic area, the electrical stimulation of which produces hyperphagia (*1*) and whose destruction leads to aphagia (*2*), and the medial part of the hypothalamus, mainly the ventromedial nucleus, whose stimulation decreases food intake (*3*) while destruction results in hyperphagia and obesity (*4*). Anand and Brobeck (*2*) postulated that the lateral hypothalamic area, a "feeding center," contains a basic mechanism for food intake, while the ventromedial nucleus, a "satiation center," contains an inhibitory one. The present study was undertaken to get a better understanding of the relations between feeding and satiation centers during elicitation of alimentary instrumental conditioned reflexes in unanesthetized animals in which electrical stimulation of the hypothalamus was applied.

Five adult goats were used. First an instrumental conditioned reflex of putting the left foreleg on the food tray was established in all goats. The reflex was elaborated to the experimental situation without the use of a sporadic stimulus; every conditioned movement was reinforced by food. After several weeks of the daily training, three unipolar electrodes were put into the medial part of the hypothalamus in all goats, under local anesthesia (Polocain, 2 percent), according to the Hess method (*5*) adapted for goats by Andersson (*6*). In two goats three further electrodes were placed in the lateral hypothalamic area, ipsilaterally in one goat and contralaterally in the other (Fig. 1). The indifferent electrode was attached to the skin of the head. Immediately after insertion of the electrodes, the animal was brought to the experimental pen where, as was usual, it began to perform the conditioned movements and eat the food given as reinforcement. Then the electrical stimulation (0.5 to 1 volt, 50 pulses/sec) was applied.

We found that stimulation of a number of points in the medial part of the hypothalamus caused cessation of the act of eating in hungry animals. In many cases the reaction was a defensive one and the animal not only jumped back from the food tray but also manifested fear and restlessness which lasted for several minutes after the withdrawal of the stimulation.

On the other hand, there were other points of the medial hypothalamus, which we call "inhibitory" points, whose stimulation evoked cessation of eating and sudden ejection of the food from the mouth, without any defensive reaction. The trained movements were also absent during stimulation, and the animal stood quietly before the food tray. In some cases only a decrease in the intensity of eating and in the frequency of conditioned movements was observed. When the stimulation lasted more than 1 minute, the goats usually went away from the food tray and sometimes lay down. However, when the stimulation was switched off, the animals almost immediately returned to the food tray, performed the trained movements, and again began to eat food. In two goats (Nos. 16 and 17) an increase in the frequency of the trained movements, after the withdrawal of the stimulation, was observed (Fig. 2*a*).

When stimulation of an "inhibitory" point was applied to completely satiated goats that did not want either to perform conditioned movements or to eat (Nos. 13, 14, and 15), no visible effect was observed during stimulation. However, just after the current was switched off, the animals, in spite of being fully satiated, came to the food tray, performed several trained movements, and consumed the portions of food which were presented (Fig. 2*b*). This effect, especially striking in two goats (Nos. 13 and 15), lasted usually some seconds, and then the animals left the food tray.

In two satiated goats (Nos. 14 and 15) stimulation of the lateral hypothalamic area was applied. This elicited the trained movements and eating (*7*). When, on the background of this "alimentary" stimulation, an "inhibitory" point was stimulated, eating became less intense or ceased altogether. The trained movements were less frequent or else disappeared. After the "inhibitory" stimulation was switched off, a transitory increase in the frequency of the conditioned movements was often observed (Fig. 2*c*).

The results obtained seem to support the hypothesis of Anand and Brobeck (*2*) on the hypothalamic mechanism of the regulation of food intake. There is no doubt that in our experiments electrical stimulation of some medial parts of the hypothalamus, called here "inhibitory" parts, exerted an inhibitory

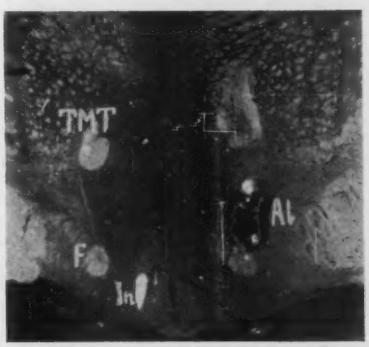


Fig. 1. Frontal section of the hypothalamus of goat No. 14. *Al*, site (coagulated) of electrical stimulation which evoked conditioned reaction and food intake in satiated goat; *In*, point at which inhibition of conditioned reaction and food intake was evoked by electrical stimulation; *F*, col. fornicis descendens; *TMT*, mammillothalamic tract.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

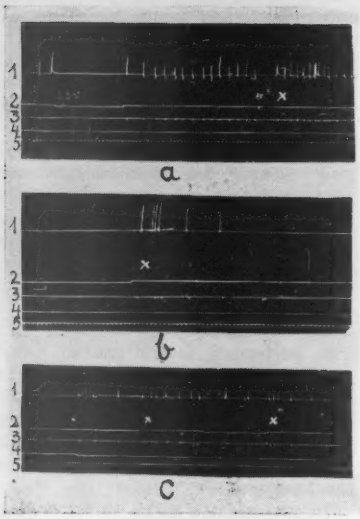


Fig. 2. Kimograms of experiments with goat No. 16 (*a*), No. 15 (*b*), and No. 14 (*c*). 1, conditioned reaction; 2, electrical stimulation of medial part of the hypothalamus ("inhibitory" stimulation); 3, food giving; 4, electrical stimulation of the lateral hypothalamus ("alimentary" stimulation); 5, time (5 seconds); *x*, moment of increase or reappearance of reaction after switching off the "inhibitory" stimulation.

effect on the act of eating as well as on the alimentary instrumental conditioned reflexes. Moreover, a noteworthy "off effect" was observed, which may be considered as a kind of rebound phenomenon. It should be stressed that this latter was present only at "inhibitory" points; it was not observed at those points where the stimulation evoked defensive reactions.

W. WYRWICKA
C. DOBRZECKA
Department of Neurophysiology, Nencki Institute of Experimental Biology, Warsaw, Poland

References

1. M. Brügger, *Helv. Physiol. et Pharmacol. Acta* **1**, 183 (1943); J. M. R. Delgado and B. K. Anand, *Am. J. Physiol.* **172**, 162 (1953); S. Larsson, *Acta Physiol. Scand.* **32**, Suppl. 115 (1954).
2. B. K. Anand and J. R. Brobeck, *Yale J. Biol. Med.* **24**, 123 (1951).
3. B. K. Anand, Symposia and Special Lectures, International Congress of Physiological Sciences, 21st Congr. (1959), p. 196.
4. A. W. Hetherington and S. W. Ranson, *Anat. Record* **78**, 149 (1940); J. R. Brobeck, J. Tepperman, C. N. H. Long, *Yale J. Biol. Med.* **15**, 831 (1943); B. K. Anand and J. R. Brobeck, *Yale J. Biol. Med.* **24**, 123 (1951).
5. W. R. Hess, *Das Zwischenhirn* (Schwabe, Basel, Switzerland, 1949).
6. B. Andersson, *Acta Physiol. Scand.* **23**, 8 (1951).
7. E. Grastyán, K. Lissák, F. Kékési, *Acta Physiol. Acad. Sci. Hung.* **9**, 133 (1956); N. E. Miller, *Science* **126**, 1271 (1957); W. Wyrwicka, C. Dobrzecka, R. Tarnecki, *Science* **130**, 336 (1959).

20 June 1960

Stimulation of Postirradiation Recovery of Cells by Cutting

Abstract. X-rays and ultraviolet radiations delay regeneration and division of *Blepharisma undulans.* Irradiated blepharisma which have not been cut divide once or twice fairly soon after the controls, then they cease dividing for a period of time (stasis) which may last for many hours or even days. Once they recover from stasis they divide at a rate comparable to controls. Cut, irradiated blepharisma, on the other hand, having to replace lost parts, start to divide later than the uncut irradiated individuals, but little if any stasis occurs. As a consequence, although irradiated with the same dosage, cut individuals recover a normal rate of division sooner than uncut ones.

In the course of studies on the effects of x-rays and ultraviolet radiations on the regeneration of *Blepharisma undulans* it was noted that individuals which had been cut just before or after irradiation appeared to divide faster than uncut irradiated individuals, inasmuch as after a lapse of time more were present in cultures from cut, irradiated individuals than in cultures from uncut, irradiated ones (*1*).

To determine whether, by itself, amputation of part of a protozoan stimulates division of the cell, the division rate of blepharisma from which the hypostome had been removed was determined. The results show that the operation does not stimulate division, rather it delays division by 8 to 12 hours; that is, by about the time it takes for an individual to reconstitute the lost oral structures necessary for feeding (5.5 hours) plus the time required to rebuild the mass of protoplasm removed (3 to 7 hours). Regeneration occurs at the expense of nutrients stored in the cell and is completed even in the absence of external food sources. When these internal stores are reduced by several days of starvation preceding cutting, regeneration takes several hours longer than in unstarved individuals, indicating that it is now more difficult to mobilize the materials required for regeneration. Once division starts after cutting, it goes on at the same rate as in uncut controls (Fig. 1).

A study of the postregeneration division of blepharisma showed that the divisions which immediately follow irradiation are delayed in both cut and uncut irradiated individuals. However, the uncut blepharisma exposed to substantial doses of either x-rays or ultraviolet radiations divide once or twice, then stop dividing for a period (stasis) which may last for many hours or even days (Fig. 1). Blepharisma cut after irradiation usually show little or no stasis. Therefore, even if the first few divisions of cut irradiated individuals are delayed as compared to uncut irradiated ones, they soon catch up with and then surpass them (Fig. 1).

This is most clearly shown in Table 1, which summarizes the differences in generation time for the first and third divisions in cut and uncut individuals. For controls (unirradiated) this is about the same for both divisions. For the irradiated blepharisma one might expect the same value as for the controls if both cut and uncut individuals were equally affected by the radiations and cutting did not affect their sensitivity. Actually the difference in generation time for the first division is greater for cut and uncut irradiated animals than for the two controls, suggesting initial compounding of the damage resulting from radiation and cutting. Much more striking is the subsequent reversal of the relative positions of cut and uncut individuals, for with few exceptions, by the third division after irradiation, the progeny of cut, irradiated blepharisma are well ahead of the uncut, irradiated ones, as indicated by the negative values.

The upshot of these experiments (*2*) is that in some way cutting seems to enable the animals to bypass the reactions which cause stasis. Kimball *et al.* (*3*) postulate that division delay in ciliates, and possibly in all cells, consists of at least two phases: (i) retardation of the first and sometimes the second postirradiation division, from which the cell soon recovers, and (ii) a long but not permanent cessation of division (stasis). The first phase of division delay they consider to result from an effect of the radiations on the mitotic apparatus; the second phase, from failure to synthesize cell materials. When the synthetic apparatus of the cell is finally repaired, the cell once again begins to grow and divide. Once division starts, the irradiation injury has been overcome. The site of protein and protoplasmic synthesis is thought to be in the ribonucleic acid–rich microsomal component of the cytoplasm (*4*). If the microsomes are inactivated (for example, by ribonuclease), synthesis ceases until more microsomes (ribosomes) are reformed. The division delay registered as stasis after irradiation may correspond to the period of replenishment of ribonucleic acid microsomes.

Cutting blepharisma is known to induce macronuclear reorganization which has been described by Suzuki (*5*) and has been verified here for both varieties of *Blepharisma undulans* (*americanus* and *japonicus*). In the present study irradiation was observed to retard the reorganization of the macronucleus required for regeneration

of the cut cells. Macronuclear activity is induced by cutting cells either before or after irradiation; such a reorganization does not occur in uncut irradiated cells, that is, irradiation by itself does not induce macronuclear reorganization. It is therefore conceivable that the block to division in uncut irradiated cells observed as a "stasis" has its locus in the synthetic ribosomes of the cells. When macronuclear reorganization is induced by cutting, new ribosomes may be liberated into the cytoplasm of the cut animals making possible synthesis of new cytoplasmic material. The cut blepharisma, upon regeneration, therefore, grow and later divide with little or no stasis. This hypothesis should be susceptible to test with some of the cytochemical methods now available.

ARTHUR C. GIESE
MOLLY LUSIGNAN
Department of Biological Sciences, Stanford University, Stanford, California

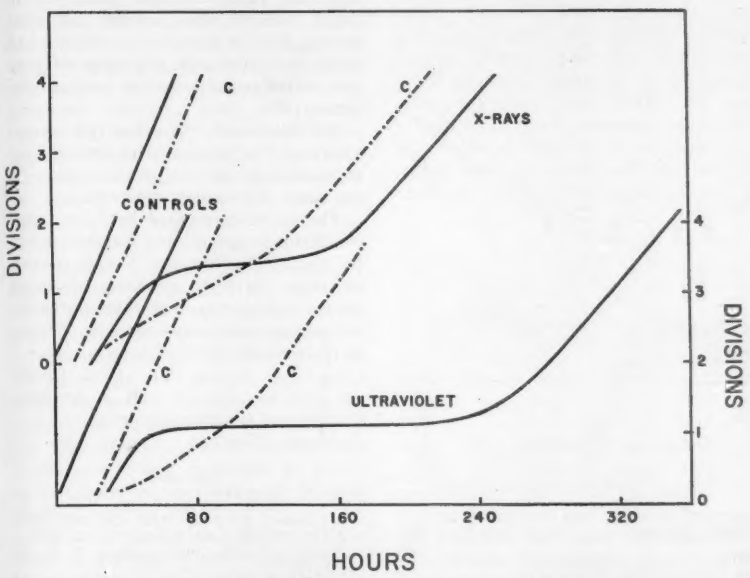


Fig. 1. Illustrative experiments showing the effects of cutting on the recovery of blepharisma from radiation injury (4600 erg/mm² of ultraviolet light at λ 2654 A and 84,600 r of 40-kv x-rays). The smoothed curves were drawn through 7 to 15 points for each experimental series. The example shown of the differential effect of ultraviolet on cut and uncut blepharisma is the most extreme observed. *C* stands for cut, hours refers to hours after treatment and isolation for tests.

Table 1. Stimulation of division of irradiated blepharisma by cutting. Part of the variability in the last four columns results from use of a nonsynchronized population, part from variation in position of the cut.

Dosage		Cut minus uncut (hours)			
		Control		Irradiated	
Ultraviolet (erg/mm²)	X-ray (r)	Div. 1	Div. 3	Div. 1	Div. 3
4025		19.0	17.5	+14.0	+5.5
4025				+14.5	−25.0
4600		26.0	29.0	+33.0	+25.0
4600		18.5	16.5	+14.5	−18.5
4600		10.0	8.5	−35.0	−26.5
4600		24.0	24.0	+46.0	−16.3
4600		18.0	20.5	+28.0	−54.5
4600*‡		17.0	19.5	+27.0	+1.0†
4600*‡		20.0	22.0	+37.5	−14.0
4025		14.0	18.0	+59.0	−58.0
4025‡				+90.0	+9.0†
3450		19.0	20.0	+20.0	−11.0
3450‡				+80.0	−47.0
4025		17.0	19.0	+16.0	−45.0
4025‡				+49.0	−46.0
4025		13.0	14.0	+6.0	−109.0
4025‡				+49.0	−91.0
4025		13.0	14.0	+1.0	−106.0
4025‡				+55.0	−89.0
	86,400	10.0	10.5	+17.5	−19.0
	86,400	13.0	16.0	+36.0	−34.0
	86,400	16.0	18.0	+44.0	−30.0

* Cut after irradiation; in all other ultraviolet experiments blepharisma were cut ½ to 1 hour before irradiation. † The differences became negative in the fourth division after irradiation. ‡ Refers to flashing ultraviolet. Dark periods of 0.03 to 0.05 second broke the flashes of light; otherwise continuous ultraviolet was used.

References and Notes

1. A. C. Giese and M. Lusignan, *J. Gen. Physiol.*, in press.
2. The experiments were supported in part by U.S. Public Health Service, grant C-3461 (C-2).
3. R. Kimball, R. P. Geckler, N. Gaither, *J. Cellular Comp. Physiol.* **40**, 427 (1952).
4. M. L. Stephenson, L. I. Hecht, J. W. Littlefield, R. B. Loftfield, P. C. Zamecknik, in *Subcellular Particles*, T. Hayashi, Ed. (Ronald, New York, 1959), pp. 160-171.
5. S. Suzuki, *Bull. Yamagata Univ. Nat. Sci.* **4**, 85 (1957).

13 June 1960

Verification of Earth's "Pear Shape" Gravitational Harmonic

Abstract. Predictions of the orbit of the Transit 1B satellite were systematically in error until account was taken of a third-order gravitational harmonic. The amplitude deduced for this harmonic by O'Keefe from the Vanguard I orbit serves very well, even though the orbits and the methods of observation and orbit fitting for the two satellites are quite different.

From the motion of the earth satellite 1958β (Vanguard I) O'Keefe, Eckles, and Squires (*1*) recognized and evaluated the amplitude of the third-order zonal harmonic in the earth's gravitational field. This odd-order harmonic produces a north-south asymmetry in the earth's field and corresponds to a "pear shaped" figure of the earth. The existence and amplitude of this harmonic have now been confirmed by analysis of the motion of the satellite 1960γ (Transit 1B). This satellite is part of the Transit navigation system under development by the Applied Physics Laboratory of The Johns Hopkins University for the U.S. Navy and was launched by the Air Force on 13 April 1960. The confirmation of the third order harmonic is remarkable in itself, and further remarkable because the satellite orbit, the observation method, and the orbit-fitting procedures were all different from those used in the earlier study of Vanguard. It is also remarkable because data from a very short period of time, 1 month, sufficed for the confirmation.

Table 1 brings out the differences between the investigations of 1958β

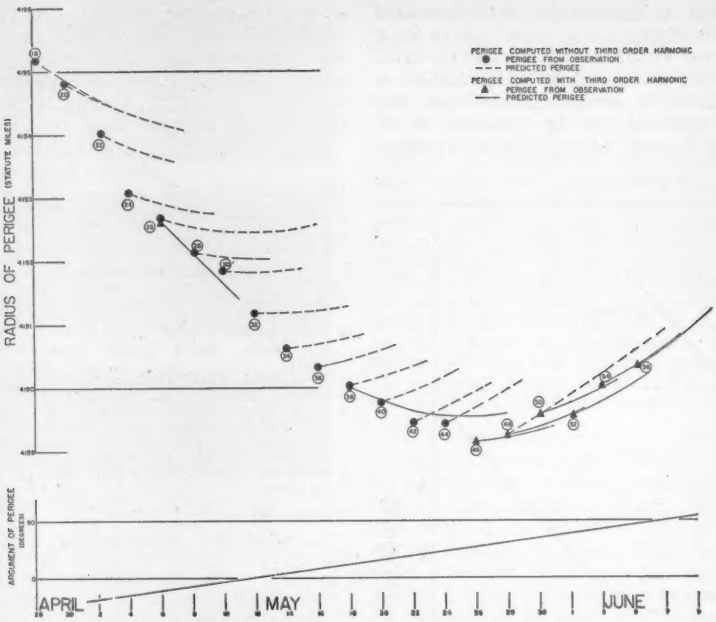


Fig. 1. Perigee observation and prediction for Transit 1B.

and of 1960γ. The Doppler observations of 1960γ at five of the six tracking stations were on the 324-to-54 Mcy/sec coherent frequencies radiated by the satellite. The received frequencies were combined in the data processing to eliminate the first-order effects of ionospheric refractions. One of the stations observed on the 216-to-162 Mcy/sec coherent frequencies with an analog combination to eliminate the first-order ionospheric refraction effects. The numerical integration for the Transit orbit takes account of various gravitational harmonics and of atmospheric drag, the air density being taken as a function of height only.

The story of the confirmation of the third-order harmonic is much like that of the original discovery. Without the third-order harmonic, the predicted perigee distance was found to deviate systematically from the distance deduced from subsequent observations. However, with a third-order harmonic of 0.24 $Mm^6/ksec^2$, as an average of O'Keefe's 0.25 and Kozai's (*2*) 0.228, the bias between the predicted and subsequently determined perigee distances is essentially removed.

Table 1. Data on 1958β and 1960γ earth satellites.

Feature	1958β	1960γ
Perigee height	410 mi	230 mi
Apogee height	2450 mi	470 mi
Inclination	34°	51°
Tracking system	IGY Minitrack system	Doppler data from six Northern-Hemisphere stations
Orbit computation	General oblateness perturbation	Numerical integration

This is shown in Fig. 1. The encircled numbers are the day numbers. The solid circles represent the perigee distances every 2 days as determined from the various Doppler measurements obtained during one day. The measurements were used to estimate first the orbital position and velocity vectors at an epoch shortly before the first observation of the day. The perigee distance given is the perigee distance computed from this position and velocity for the osculating Keplerian orbit at the first ascending equator-crossing after epoch. (It is not the osculating value at epoch, nor a mean osculating value over a revolution, as was used in the preliminary Vanguard analysis.) The dashed curves forward of the circles are the loci of the predicted perigee distances at subsequent ascending equator-crossings. Both the circles and the dashed curves are based on orbits estimated without a third-order gravitational harmonic. It is apparent that the predictions deviate systematically from those found through subsequent observation.

In Fig. 1 the triangles represent perigee distances determined when the third-order harmonic is used in the computations, and the solid lines represent the corresponding predictions. It is seen that the errors of prediction are now close to the noise level. A measure of the accuracy of the third-order harmonic based on our data is therefore the ratio of the uncertainty in the slope of the curve through the observed values to the difference in slope between the dashed and solid curves. This is roughly 5 percent. The lower plot shows the argument of perigee corresponding to the perigee distances.

Variations in the observed eccentricity of the Transit orbit are also accounted for, just as dramatically, by the same third-order harmonic.

The results presented here are based on limited operational computations. By special analyses over longer periods of time there is promise of much greater refinement in the determination of gravitational and geodetic parameters from the Transit system.

C. J. Cohen
R. J. Anderle
U.S. Naval Weapons Laboratory, Dahlgren, Virginia

References

1. J. A. O'Keefe and A. Eckels, *Harvard Announcement Card No. 1520* (29 Dec. 1958); J. A. O'Keefe, A. Eckels, R. K. Squires, *Science* **129**, 565 (1959); *Astron. J.* **64**, 245 (1959).
2. Y. Kozai, *Smithsonian Astrophys. Observ. Spec. Rept. 22* (1959).

13 June 1960

Temperate Pollen Genera in the Eocene (Claiborne) Flora, Alabama

Abstract. Pollen, spores, hystrichospherids, dinoflagellates, and the fresh-water alga *Pediastrum* occur in marine clays at the classic Claiborne Bluffs locality, Alabama. The presence of *Ephedra* pollen provides the first documented Tertiary record of this genus from the southeastern states. The occurrence of several characteristically temperate genera lends support to the idea that a deciduous hardwood forest was present in the Appalachian uplands during the Eocene.

Thanks to the prodigious work of E. W. Berry, the fossil floras of the Coastal Plain and Mississippi Embayment, largely preserved in near-shore marine sediments, provide a unique record of successive change through time of strand and lowland vegetation. Among the most prolific, with remains throughout many of the South Atlantic and Gulf states, is the triad of well-known Eocene floras: Wilcox (Lower), Claiborne (Middle), and Jackson (Upper). From these Berry described about 200 genera of plants (many common

to the three floras) and hundreds of species. By comparison with living species, he interpreted the fossils as lowland, chiefly coastal-strand, lagoon, and estuarine types with affinities largely with the near-shore vegetation of subtropical and tropical Mexico and Central and South America. He considered none of the Eocene floras, however, to be "strictly tropical" (*1*, p. 1).

Among numerous genera now largely confined to the equatorial lowlands, Berry identified a few with temperate implications, in what he called warm-temperate (Wilcox) and subtropical-tropical (Claiborne, Jackson) floras. Using Berry's floral lists, Cain (*2*) demonstrated high correspondence at the *generic* level between the Eocene floras and the vegetation of the temperate southern Appalachians. Sharp (*3*) showed a similar correspondence between the Wilcox and the vegetation of the eastern Mexican escarpment region, with its mixture of temperate and tropical climates (*3*, *4*). Brown (*5*, *6*, *7*) added to the Wilcox five other temperate genera represented by relatively rare specimens, and predicted that "Examples of other missing temperate genera will doubtless be found as collectors become aware of the possibilities" (*6*, p. 350).

Thanks to the medium of microscopic study, a number of the "missing temperate genera" can now be included in the southeastern Middle Eocene flora. It is suggested that they lived in interior sites and possibly on the upland slopes of the Appalachians, which appear to have been strongly emergent during the early Tertiary. The value of adding plant microfossils to the Eocene floral picture cannot be overestimated. For pollen, widely scattered and unrestricted in its distribution, may be supposed to shed considerable light on the nature of the regional (and upland) forest, although mega-remains from these facets of the flora were less accessible to lowland sites of deposition than structures of coastal plants.

The plant microfossils and other microorganisms have been concentrated from the uppermost formation (Gosport sand) of the Claiborne group at Claiborne Bluffs, southern Alabama. The Gosport is here disconformably overlain by the Ocala limestone (Upper Eocene) and underlain by the Lisbon formation. A coarse, highly glauconitic marine sandstone with abundant invertebrate fossils, the Gosport locally contains thin clay beds from which plant megafossils (*1*), as well as pollen, have been recovered (Table 1, Fig. 1). Berry considered the 13 megafossil genera represented in the Gosport sand to be the commonest Claiborne plants. The vascular plants new to the florule, including essentially all the identified genera characteristic of, or largely restricted to, regions of temperate climate, are new as well to the southeast Middle Eocene flora. Several of these genera have megafossil remains in Cretaceous Coastal Plain sediments (Table 1): *Abies* (*Abietites*) is not otherwise reported as a fossil in the East; tulip-tree is encountered again only in the Pleistocene; pine remains (Eocene, Miocene) are known only from the Middle Atlantic States before the Pleistocene. Fossil elm first appears in the Miocene; alder, *Carpinus* and *Ostrya* are not known from pre-Pleistocene sediments. As otherwise reported (*8*, *9*) from the middle-south Atlantic and Gulf states, birch and beech (Pliocene, Pleistocene) occur also in the Wilcox (*6*, *7*); linden (Pleistocene) and chestnut (Pliocene) in the Jackson (*1*); sweet-gum (Pleistocene) in the Wilcox and Jackson (*1*, *10*). The absence of these genera from the Claiborne may be due to chance or to a change in their distribution. The same is true of oak and holly, whose megafossil histories in the East are essentially complete through the Tertiary into the Cretaceous, although Berry referred oak-like remains in the southeastern Eocene floras to *Dryophyllum*, and reported *Ilex* in this area only from the Wilcox.

The presence of *Ephedra* among the Claiborne assemblage arouses much interest in the first record of this genus in eastern American Tertiary sediments

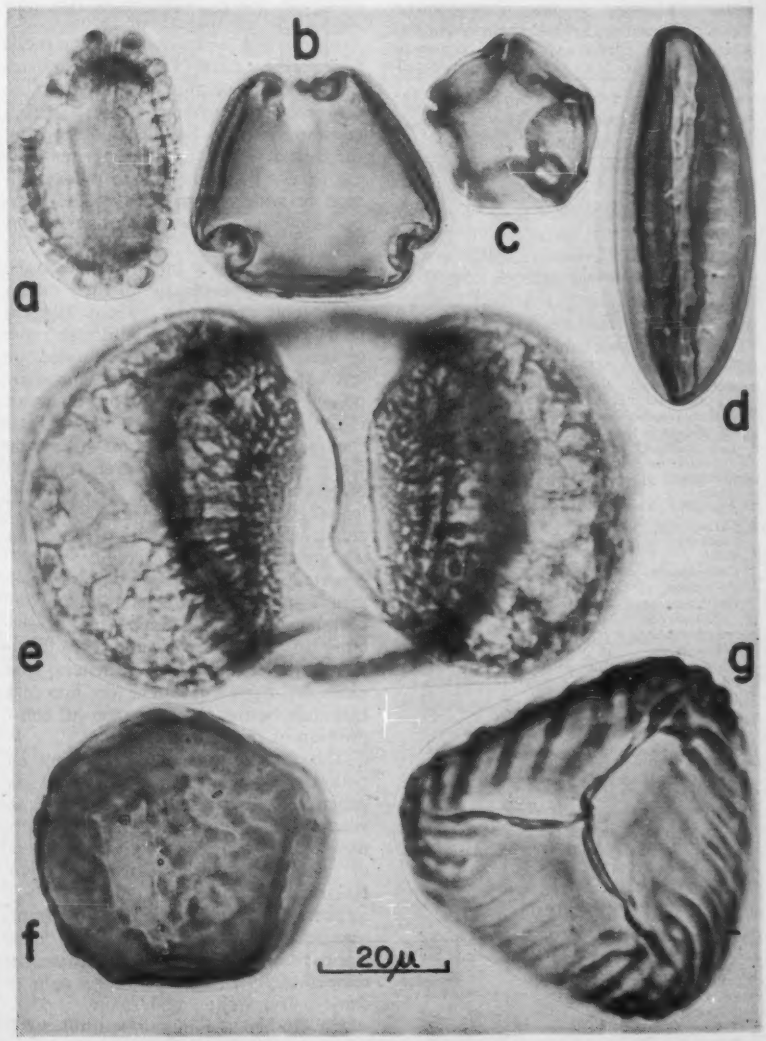


Fig. 1. Photomicrograph of Claiborne (Middle Eocene) plant microfossils. (*a*) *Ilex* (holly); (*b*) *Nyssa* (tupelo); (*c*) *Alnus* (alder); (*d*) *Ephedra* (Mormon tea); (*e*) *Pinus* (pine); (*f*) *Ulmus* (elm); (*g*) *Aneimia* (compare *Mohria*).

(*11*). The North American ephedras now occur widely in and at the margins of the warm-temperate, subtropical deserts: their habitats show wide range in elevation, but are characterized generally by shallow, rapidly drying, highly permeable soil. To account for the presence of the Claiborne ephedras in an environment of high atmospheric humidity (*1*), it is possible to speculate that local conditions of edaphic aridity may have existed in highly insolated sites, on shifting sands, beach dunes, or sand-flats adjacent to the coast, without surmising that this species had environmental requirements entirely different from modern ones. However, it seems as plausible to question the assumption that early Tertiary ephedras were physiologically as fully differentiated as the living species. Thus the tentative suggestion may be put forward that the Claiborne species did not have the limiting adaptive relations of living ephedras, although it may have been confined to drier, better-drained sites where it survived largely because of limited competition with associates.

Table 1. Identified plant fossils from the Gosport sand, Claiborne group. *C*, genera or families reported from other Claiborne localities.

Group	Microfossils	Megafossils (*1*)
Hystrichospherids	+	
Algae		
Dinoflagellates	+	
Pediastrum spp.	+	
Ferns		
Aneimia (cf. *Mohria*)	+	C
Lygodium		+
Polypodiaceae (cf. *Polypodium* spp.)	+	
Acrostichum		+
Gymnosperms		
*Abies**?	+	
Ephedra (cf. *E. nevadensis*)	+	
*Pinus** (*haploxylon* and *sylvestris* types)	+	
Taxodiaceae-Cupressaceae	+	C
Angiosperms		
Alnus	+	
*Betula**?	+	
Carya	+	C
Castanea	+	
Celtis	+?	C
Citrophyllum		+
Coccoloba		+
Combretaceae	+	
Conocarpus		+
Laguncularia		+
Terminalia		+
cf. *Engelhardtia-Alfaroa*	+	
*Fagus**	+	
Gramineae	+	
Arundo		+
*Ilex**	+	
Juglans	+	C
Liquidambar	+	
*Liriodendron**	+	
Moraceae	+	
Ficus		+
Myrica		+
Myrtaceae	+	C
Nectandra		+
Nyssa	+	C
Ocotea (*Oreodaphne*, *Mespilodaphne*)		+
Onagraceae	+	
Ostrya-Carpinus	+	
Palmae	+	C
*Quercus**	+	
Sapindaceae cf. *Cardiospermum*	+	
Sapindus		+
Sapotaceae	+	C
Tilia	+	
Ulmus (cf. *Zelkova*)	+	

* Genera new to the Claiborne with Cretaceous fossil records in the middle-south Atlantic and Gulf regions (*8*, *9*).

Bearing in mind the several temperate genera now added to the Middle Eocene flora, it seems possible to postulate (i) a long southeast history for some genera whose remains have been found in this area, heretofore, only in late Tertiary sediments, and (ii) the continued survival, possibly from the Upper Cretaceous, of a temperate assemblage whose members largely lack early Tertiary megafossil records. The fossil records lend support to the thesis advanced by Cain (*2*) which postulates the antiquity of the vegetation of the southern Appalachians, and its essential constancy in the Southeast throughout the Tertiary. That none of the temperate genera were among the more common or widely distributed of the Claiborne plants at low elevations is supported by two facts: (i) essentially all of them have only microfossil records; (ii) the total percentage of their pollen is a small proportion (about 20 percent) of the microflora, although most of these genera are wind-pollinated, or less obligately entemophilous, and their pollen would tend to be more common if the plants had been abundant. Thus the probability of distant transport seems to explain the apparent mixture of deciduous hardwoods and broad-leafed evergreens of now unlike climatic zones, without the necessity of assuming a "greater genetic variability at the generic level" (*3*) or that many of these genera have changed their climatic requirements through time. One or the other of these factors may also have been operative for some genera, for example, *Ephedra*, but I do not feel that they best explain the over-all composition of the Gosport florule.

The temperate genera occurring as pollen, together with some found as megafossils, represent an assemblage which can be compared directly with the existing deciduous hardwood forest of middle latitudes, and the temperate Holarctic Eocene flora, although admittedly some of the more important members of both are still missing. This comparison strongly suggests that the temperate pollen stems from an upland community, quite modern in aspect, which clothed the inland foothills and lower slopes of the Eocene Appalachians, while a subtropical flora thrived at lower elevations and along the strand. A close parallel is found today in the eastern Mexican forest, where communities of the tropical "tierra caliente" merge with those of the temperate "tierra templada" at elevations of about 3300 to 4000 feet at "the dividing line between elements of the great arctotertiary and neo-tropical floristic regions of classical phytogeography" (*4*, p. 313; *12*).

JANE GRAY

Geochronology Laboratories, University of Arizona, Tucson

References and Notes

1. E. W. Berry, *U.S. Geol. Survey Profess. Paper No.* **92** (1924).
2. S. A. Cain, *Bull. Torrey Botan. Club* **70**, 213 (1943).
3. A. J. Sharp, *Evolution* **5**, 1 (1951).
4. F. Miranda and A. J. Sharp, *Ecology* **31**, 313 (1950).
5. R. W. Brown, *J. Wash. Acad. Sci.* **30**, 344 (1940).
6. ———, *ibid.* **34**, 349 (1944).
7. ———, *ibid.* **36**, 344 (1946).
8. F. H. Knowlton, *U.S. Geol. Survey Bull. No. 696* (1919); R. S. LaMotte, *U.S. Geol. Survey Bull. No. 924* (1944).
9. R. S. LaMotte, *Geol. Soc. Am., Mem. No. 51* (1952).
10. E. W. Berry, *U.S. Geol. Survey Profess. Paper No.* **156** (1930).
11. The abundant, well-preserved grains do not suggest transport from distant inland regions of more continental climate.
12. This report is contribution No. 40, Geochronology Laboratories.

27 May 1960

Isotopic and Zoogeographic Paleotemperatures of Californian Pleistocene Mollusca

Abstract. Pleistocene paleotemperatures inferred from zoogeographic evidence are based on temperatures at species' range limits at present. Paleotemperatures inferred from isotopic evidence are based on average former shell-growth temperatures which commonly, but not exclusively, lie between present range-limiting temperatures. With allowance for these differences, the two lines of evidence suggest similar thermal patterns.

Average temperatures of shell deposition of 43 specimens representing 22 molluscan species from 13 Californian Pleistocene fossil assemblages were estimated by the O^{16}/O^{18} method (*1*). For these specimens, Table 1 lists (i) isotopic paleotemperatures (based on average Recent sea water, with instrumental error $\pm$ 1°C), (ii) present approximate range-limiting temperatures (average February temperatures at northern and average August temperatures at southern range end-points, corrected for depth), and (iii) the most probable depth at which each specimen lived [based on the present ecology of the species and supported by paleoecologic analyses of the 13 fossil assemblages (*2*)].

A few forms yielded isotopic paleo-

temperatures outside the range of average monthly temperatures at which they live today. The low shell-growth temperatures of *Acanthina lugubris* seem readily explicable, for this form lives in low-temperature patches along western Baja California where cool waters well up near the shore (*3*). Evidently *A. lugubris* secretes shell at low temperatures. If its northern range endpoint is thermally controlled it must be by spawning or larval survival temperatures, not by adult survival temperatures. The range-limiting temperature estimate in Table 1 does not take this into account and can therefore be too high for a shell-growth temperature. *Stramonita biserialis,* associated with *Acanthina lugubris* in the Pleistocene, also yielded low shell-growth temperatures for its present range, probably for the same reason as *A. lugubris.* Two of three shell-growth temperatures of *Dosinia ponderosa* are lower than expected. Evidently *D. ponderosa* can deposit shell at temperatures lower than necessary for other functions at times in its life. For *Panomya beringianus,* only two depth records are available, and thus the significance of its unexpectedly high isotopic paleotemperature cannot be assessed.

Among Upper Pleistocene specimens (localities 1 to 8) the most striking temperature contrasts are between forms from exposed-shore sites (localities 2, 4, 5, 7, and 8) and forms from partially protected habitats (localities 1 and 6) or areas where warm waters may be expected to have piled up (locality 3). Northern extralimital species *(Tegula brunnea* and *T. montereyi)* are common in exposed-shore assemblages (*4*) and have low isotopic paleotemperatures; southern species *(Dosinia ponderosa* and *Muricanthus nigritus)* in other assemblages (*4*) have high isotopic paleotemperatures. Even relatively eurythermal and ecologically ubiquitous forms appear to reflect this contrast: *Olivella biplicata* has commonly given higher temperatures from protected (about 15° to 16°C) than from exposed (about 12° to 13°C) assemblages. However a single shell of *O. biplicata* from a protected assemblage (locality 1) gave a low temperature. This is not surprising, for both faunal and isotopic evidence indicates the contemporaneous presence of cool water at locality 2, only a few miles to the south. Waters cooler than today's at exposed sites and warmer than today's at protected sites are thus suggested for the Upper Pleistocene.

To judge from zoogeographic evidence, Lower Pleistocene faunas from the Lomita marl (locality 9) thermally resemble Upper Pleistocene faunas (*2*). Isotopic paleotemperatures seem to support this resemblance, for an exposed-shore frigophile *(Tegula)* yielded a low temperature, and a more protected shallow-water thermophile *(Eupleura)* yielded a high temperature. A deep outer sublittoral association (75 to 100 fathoms) from Lower Pleistocene silts containing a large northern element (locality 10) yielded the lowest paleotemperatures. Note that the littoral *Tegula,* doubtless washed from nearby shores, yielded a much higher temperature than the species from deeper water. Forms from locality 11 representing shallower depths (25 to 35 fathoms) yielded higher isotopic paleotemperatures. Shells from Lower Pleistocene sands, deposited in depths of 15 to 25 fathoms (locality 12) and 25 to 50 fathoms (locality 13) yielded paleotemperatures commensurate with those from the silts, depth for depth. Evidently the Timms Point silt and San Pedro sand thermal regimes were similar, and temperatures were somewhat cooler than they are in comparable habitats in the region today (*5*).

Table 1. Isotopic and zoogeographic paleotemperature estimates of Pleistocene Mollusca (*P,* pelecypods; *G,* gastropods) by locality, with estimated living depth.

Locality	Species	Depth (fathoms)	Isotopic temp. (°C)	Present range-limiting temp. (°C)
1. N. San Pedro, Calif., UCLA 1053	*Dosinia ponderosa* (Gray) P	0–5	18.2	18–29
	Olivella biplicata (Sowerby) G	0–5	15.2, 12.3	8–23
2. S. San Pedro, Calif., UCLA 4101	*Tegula montereyi* (Kiener) G	shore	11.3, 12.3	10–14
	Olivella biplicata (Sowerby) G	0–15	12.3, 12.6	8–23
3. Newport Beach, Calif., UCLA 3195	*Dosinia ponderosa* (Gray) P	0–10	17.1	18–29
	Muricanthus radix (Philippi) G	0–10	20.8	21–29
4. Point Loma, Calif., UCLA 3605	*Tegula montereyi* (Kiener) G	shore	12.4, 12.6	10–14
	Littorina scutulata (Gould) G	shore	13.8	6–29
	Stramonita biserialis (Blain) G	shore	13.1	17–29
	Acanthina lugubris (Sowerby) G	shore	14.0, 15.2	14–23
	Olivella biplicata (Sowerby) G	0–5	11.6	8–23
5. Tahiti Beach, Baja Calif., UCLA 3160	*Littorina scutulata* (Gould) G	shore	13.4	6–29
	Acanthina lugubris (Sowerby) G	shore	12.8	14–23
	Olivella biplicata (Sowerby) G	0–5	13.3	8–23
6. San Quintin, Baja Calif., UCLA 2411	*Dosinia ponderosa* (Gray) P	0–10	15.6	18–29
	Macoma yoldiformis (Carpenter) P	0–10	13.0	7–17
	Olivella biplicata (Sowerby) G	0–10	16.9	8–23
7. N. of Punta Baja, Baja, Calif., UCLA 2723	*Olivella biplicata* (Sowerby) G	0–5	11.7	8–23
8. Punta Baja, Baja Calif., UCLA 2714	*Macoma irus* (Hanley) P	0–2	11.0	2–16
	Tegula brunnea (Forbes) G	shore	11.2	9–14
	Tegula montereyi (Kiener) G	shore	11.8	10–14
	Littorina scutulata (Gould) G	shore	13.8	6–29
	Acanthina lugubris (Sowerby) G	shore	11.3, 11.9	14–23
9. Lomita marl, Hilltop quarry, San Pedro, Calif., UCLA 335	*Chlamys hastatus* (Sowerby) P	0–15	15.7	5–16
	Tegula montereyi (Kiener) G	shore	13.2	10–14
	Eupleura muriciformis (Broderip) G	0–15	19.0	17–29
10. Timms Point silt, Timms Point, San Pedro, Calif., UCLA 2383	*Cyclocardia occidentalis* (Stear) P	50–100	7.6	5–11
	Macoma calcarea (Gmelin) P	50–100	5.7	1–11
	Tegula funebralis (A. Adams) G	shore	13.8	8–20
	Fusitriton oregonensis (Redf.) G	50–100	5.7	2–8
11. Silt, Cheviot Hills, Calif., UCLA 3395	*Panomya beringianus* (Dall) P	25–35	12.5	2–8
	Mya truncata (Linnaeus) P	25–35	10.0	1–11
12. San Pedro sand, San Pedro, Calif., UCLA 1824	*Macoma irus* (Hanley) P	15–25	10.4	2–16
	Boreotrophon multicostatus (Esch.) G	15–25	10.7	2–14
13. San Pedro sand, Torrance, Calif., UCLA 3773	*Cyclocardia californica* (Dall) P	Extinct	8.1	
	Spisula cf. *S. falcata* (Gould) P	25–50	6.4	7–17
	Pachypoma gibberosum (Dillwyn) G	15–50	9.4	9–15

JAMES W. VALENTINE
Department of Geology, University of Missouri, Columbia
ROBERT F. MEADE
Division of Science and Mathematics, Los Angeles State College, Los Angeles, California

References and Notes

1. H. C. Urey, H. A. Lowenstam, S. Epstein, C. R. McKinney, *Bull. Geol. Soc. Am.* **62**, 399 (1951); S. Epstein, R. Buchsbaum, H. Lowenstam, H. C. Urey, *ibid.* **62**, 417; S. Epstein, R. Buchsbaum, H. Lowenstam, H. C. Urey, *ibid.* **64**, 1315 (1953).
2. J. W. Valentine and R. F. Meade, *Univ. Calif. Berkeley Publs. Geol. Sciences* **39**, in press.
3. C. L. Hubbs, personal communication.
4. J. W. Valentine, *Am. J. Sci.* **253**, 462 (1954).
5. Isotopic analyses were made at California Institute of Technology; special thanks are due Samuel Epstein for supervision of this work. D. I. Axelrod and C. E. Palmer, University of California, Los Angeles, offered helpful suggestions. Financial support was given by the Institute of Geophysics, UCLA, and ONR grant 233 (45).

5 May 1960

Meetings

Forthcoming Events

October

13–15. Academy of Psychosomatic Medicine, Philadelphia, Pa. (B. B. Moss, 55 E. Washington, Chicago 2, Ill.)

13–15. Optical Soc. of America, Boston, Mass. (M. E. Warga, OSA, 1155 16 St., NW, Washington 6)

13–15. Pavlovian Conf. on Higher Nervous Activity, New York, N.Y. (Executive Director, New York Acad. of Sciences, 2 E. 63 St., New York 21)

14–15. Society of Photographic Scientists and Engineers, symp., Washington, D.C. (F. M. Brown, Photomechanisms, Inc., Box 67, Huntington Station, N.Y.)

15. American Soc. of Safety Engineers, annual, Chicago, Ill. (A. C. Blackman, ASSE, 5 N. Wabash Ave., Chicago 2)

15–16. American Acad. of Psychotherapists, 5th annual conf., Cleveland, Ohio. (B. J. Barkley, 1856 Coventry Rd., Cleveland Heights 18, Ohio)

15–16. Science and Technology in Israel and the Middle East, 3rd annual, New York, N.Y. (D. C. Gross, American Technion Soc., 1000 Fifth Ave., New York 28)

16. American College of Dentists, Los Angeles, Calif. (O. W. Brandhorst, 4236 Lindell Blvd., St. Louis 8, Mo.)

16–22. High-Speed Photography, 5th intern. cong., Washington, D.C. (V. H. Allen, Soc. of Motion Picture and Television Engineers, 55 W. 42 St., New York 36)

16–22. Society of Motion Picture and Television Engineers, semi-annual conv., Washington, D.C. (C. S. Stodter, SMPTE, 55 W. 42 St., New York 36)

17–18. Basic Science in France and the United States, symp., New York, N. Y. (S. Roth, Office of Research Services, New York Univ., Washington Square Center, New York 3)

17–19. Adaptive Control Systems, symp., New York, N.Y. (H. Levenstein, W. L. Maxon Corp., 260 W. 34 St., New York)

17–19. American Oil Chemists' Soc., fall, New York, N.Y. (W. C. Ault, U.S. Dept. of Agriculture, Philadelphia 18, Pa.)

17–20. American Acad. of Pediatrics, Chicago, Ill. (E. H. Christopherson, 1801 Hinman Ave., Evanston, Ill.)

17–20. American Dental Assoc., Los Angeles, Calif. (H. Hillenbrand, ADA, 222 E. Superior St., Chicago, Ill.)

17–21. Neutron Pile Research, symp., Vienna, Austria. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1)

17–22. Diagnosis and Treatment of Acute Radiation Injury, Geneva, Switzerland. (World Health Organization, Palais de Nations, Geneva)

17–26. Plastics Processing, intern. cong. and exhibition, Amsterdam and Utrecht, Netherlands. (Secretariat, c/o N. V. 't Raedthuys, Tesselschadestraat 5, Amsterdam-W, Netherlands)

18. Oak Ridge Inst. of Nuclear Studies, Oak Ridge, Tenn. (W. G. Pollard, Box 117, Oak Ridge)

18–20. Mathematical Optimization Techniques, symp., Berkeley, Calif. (R. M. Oliver, Dept. of Industrial Engineering, Univ. of California, Berkeley 4)

18–21. American Dietetic Assoc., 43rd annual, Cleveland, Ohio. (M. L. Ross, Simmons College, The Fenway, Boston 15, Mass.)

19–20. American Geophysical Union, Moscow, Idaho. (W. E. Smith, 1515 Mass. Ave., N.W., Washington 5, D.C.)

19–21. Design of Experiments, 6th conf. (by invitation only), Aberdeen Proving Ground, Md. (F. G. Dressel, Office of Ordnance Research, Box CM, Duke Station, Durham, N.C.)

19–21. Space Navigation, symp., Columbus, Ohio. (Institute of Radio Engineers, 1 E. 79 St., New York 21)

19–26. Measuring Techniques and Automation, 2nd intern. cong., Düsseldorf, Germany. (Nordwestdeutsche Ausstellungs-Gesellschaft, Ehrenhof 4, Düsseldorf)

20–21. Hypervelocity, symp., Denver, Colo. (R. R. Dexter, IAS, 2 E. 64 St., New York 21)

20–22. Acoustical Soc. of America, San Francisco, Calif. (V. Salmon, Stanford Research Institute, Menlo Park, Calif.)

20–22. Institute of Management Sciences, 7th intern., New York, N.Y. (J. Townsend, IMS, 30 E. 42 St., New York 17)

21–22. Association of Midwestern College Biology Teachers, 4th annual, Mankato, Minn. (L. Zell, Mankato State College, Mankato, Minn.)

21–22. Research Approaches to Psychiatric Problems, symp., Galesburg, Ill. (T. T. Tourlentes, Galesburg State Research Hospital, Galesburg)

21-23. American College of Cardiology, St. Louis, Mo. (G. F. Greco, 114–08 Linden Blvd., Ozone Park 16, N.Y.)

21–25. American Heart Assoc., annual, St. Louis, Mo. (AHA, 44 E. 23 St., New York 10)

22. Midwest Solid State Conf., 8th annual, Lincoln, Neb. (J. W. Weymouth, Physics Dept., Univ. of Nebraska, Lincoln)

23–26. American College of Gastroenterology, Philadelphia, Pa. (D. Weiss, 33 W. 60 St., New York 23)

24–26. Medical and Biological Aspects of the Energies of Space, symp. (School of Aviation Medicine, USAF Aerospace Medical Center), San Antonio, Tex. (J. Harmon, Symposium Coordinator, Southwest Research Inst., P.O. Box 2296, San Antonio 6)

24–27. Hot Atom Effects, symp., Prague, Czechoslovakia. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1, Austria)

25–27. American Standards Assoc., natl. conf., New York, N.Y. (G. F. Hussey, Jr., AST, 70 E. 45 St., New York 17)

26–28. Animal Care Panel, 11th annual, St. Louis, Mo. (ACP, P.O. Box 299, Lemont, Ill.)

26–28. Society for Industrial Microbiology, Conf. on Antimicrobial Agents, Washington, D.C. (SIM, 2000 P St., NW, Washington 6)

27–28. Cellulose Conf., 3rd, Syracuse, N.Y. (Cellulose Research Inst., State Univ. College of Forestry, Syracuse Univ., Syracuse 10)

immediate delivery of TEXAS INSTRUMENTS "recti/riter"® & "servo/riter"* recorders

* Texas Instruments Trademark

ATOMIC accessories inc.
Subsidiary of Baird-Atomic, Inc.
811 West Merrick Rd., Valley Stream, N. Y.
CUrtis 5-9300

or Contact your Baird-Atomic sales office in:

BOSTON
33 University Road, Cambridge 38, Mass.
University 4-7420

NEW YORK
811 W. Merrick Road, Valley Stream, N. Y.
Curtis 5-5400

PHILADELPHIA
413 Johnson Street, Jenkintown, Pa.
Waverly 7-4676

PITTSBURGH
603 Laurel Drive, Monroeville, Pa.
Electric 1-1500

WASHINGTON, D. C.
9403 Fresno Road, Bethesda 14, Md.
Oliver 6-1200

ATLANTA
3127 Maple Drive N. E., Atlanta 5, Ga.
Cedar 3-8295

CHICAGO
540 N. Lake Shore Drive, Chicago 11, Ill.
Michigan 2-6755

DETROIT
30129 Minton, Livonia, Mich.
Garfield 1-7169

DALLAS
5635 Yale Blvd., Dallas 6, Texas
Emerson 1-6081

LOS ANGELES
2312 W. Redondo Beach Blvd., Gardena, Calif.
Faculty 1-4466

SAN FRANCISCO
1485 Bayshore Blvd., San Francisco 24, Calif.
Delaware 4-0515

CANADA
Suite 303, 465 Gilmour St., Ottawa, Ontario
Central 2-9810

recti/riter® recorders prove what every engineer knows . . . SIMPLICITY MEANS RELIABILITY

What simpler and more reliable actuating device can you employ in an amperage-voltage-frequency recording instrument than a d'Arsonval galvanometer . . . a trouble-free horseshoe magnet and a coil of wire? The same is true of the exclusive "recti/rite"® system . . . a simple, shock resistant trigonometric linkage that straightens the arc described by the galvanometer metering arm, changing curvilinear motion to rectilinear motion.

All the other "recti/riter" recorder features which contribute to this instrument's multi-industry acceptance and hardworking reliability are equally simple: The optional a-c or d-c drives couple directly with chart speed change gears to allow ten chart speeds; all routine operations and adjustments are performed "up front"; the non-corrosive, honed metal alloy pens, closed ink system, and large capacity ink well give you long, consistent writing performance.

With all their simplicity and reliability, "recti/riter" recorders are offered in extremely wide and useful Basic Recorder Ranges (Dual channel recorders offer combination of any two ranges):

Two Cycle Pen Response

D-c Milliampere Ranges ..... ¼ ma to 100 ma
A-c Ampere Ranges ..... 0.25 A to 25 A
D-c Ampere Range ..100 mv for use with standard shunts
Expanded Scale A-c Voltage Ranges ..... 80-130 V, 160-260 V, 320-520 V
A-c and D-c Voltage Ranges ..... 10 V to 1000 V
Frequency Ranges ..... 50, 60, 400 cps

Five Cycle Pen Response

D-c Milliampere Range ..... 5 ma

Ask the TI engineer about *customized* recorders for your OEM applications. Don't settle for any recorder until you know all the facts on the complete "recti/riter" recorder line.

TEXAS INSTRUMENTS
INCORPORATED
GEOSCIENCES & INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS • CABLE: TEXINS

The proved "recti/riter" recorder is a companion to the new "servo/riter"* recorder.

*"servo/riter" is a trademark of Texas Instruments

new england nuclear

MESCALINE-8-C^{14} HYDROCHLORIDE

100 microcuries/$65.00

CATALOG ON REQUEST

new england nuclear corp.

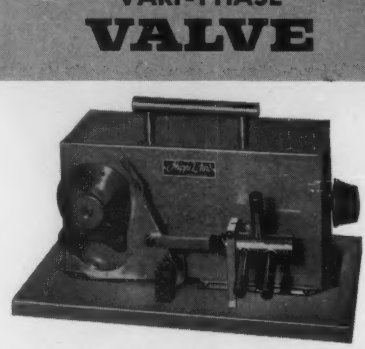
575 ALBANY STREET, BOSTON 18, MASS. Liberty 2-5964

PHIPPS & BIRD

PULMOTOR

VARI-PHASE

VALVE



For Controlling Artificial Respiration

For use with compressed air in controlling artificial respiration.

Control of one knob facilitates respiration rates of 15 to 50 per minute. Time ratio may be set to any value between 1:4 to 4:1.

Removes for easy cleaning and sterilizing.

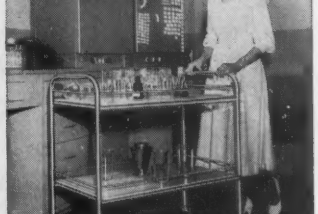
CAT. NO. 71-216

PHIPPS & BIRD, INC.

Manufacturers & Distributors of Scientific Equipment

6th & Byrd Streets - Richmond, Va.

Stop wasting time!



This sturdy, easy to move cart eliminates needless handling of samples, packages, glassware, equipment and instruments. Saves you many unnecessary trips throughout the day. We also make 18 other models, all designed to cut minutes, and hours, of unnecessary work from your job. Write today for free illustrated booklet and name of dealer nearest you handling LABCONCO CARTS.

Please send booklet on Labconco Carts

Name_____

Company_____

Street_____

City_____ State_____

LABORATORY CONSTRUCTION CO.

8811 Prospect, Kansas City 30, Mo.

the modern technique

VOLUTEC®

AEROSOL REAGENTS

by SCHUCO

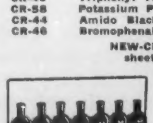
for Chromatography and Electrophoresis, Stains and Indicators

- In plastic coated glass containers for added stability, protection against light, air, bacteria.
- Eliminates any chance of accidential contamination.
- Economical, there is no waste. You use only the amount you need.
- Time saving, there are no delays for reagent preparation.
- Prevents accidental spillage, soiled clothing, work areas.

VOLUTEC—GROUP A: CHROMATOGRAPHY & ELECTROPHORESIS SPRAYS

No.	Description	Price per carton of 6-200ml containers
CR-2	Sodium 1, 2 naphthaquinone 4-sulfonate (Folins Reagent)	$12.00
CR-10	Ninhydrin 0.2% in Acetone	15.00
CR-12	Ninhydrin 0.2% in n-Butanol	15.00
CR-14	Isatin, 0.2% in n-Butanol	15.00
CR-16	Bromocresol Green, 0.1% in n-Butanol	15.00
CR-18	Ferric Chloride, 2% in n-Butanol	15.00
CR-19	p-Anisidine, 2% in n-Butanol	15.00
CR-20	Aniline Hydrogen Phthalate in n-Butanol	15.00
CR-34	m-Dinitrobenzene (Zimmerman's Reagent)	13.00
CR-41	Triphenyl Tetrazolium Chloride (Tetrazolium Red)	15 00
CR-58	Potassium Permanganate, 1% aqueous	12.00
CR-44	Amido Black 10B (for electrophoresis)	13.00
CR-46	Bromophenol Blue (for electrophoresis)	14.00

NEW-CHROMOTEC: Protective Spray for Filter Paper sheets—13.50 per Carton of 6-12 oz. containers.



KITS: One container each of the indicated reagents in free carrying and storage rack, CR-1020 One Container each of CR-10, CR-12, CR-14, CR-16, CR-18, CR-19 and CR-20. $17.00. CR-1025 One Container each of CR-2, CR-12, CR-18, CR-19, CR-34, CR-41 and CR-58. 16.00.

WRITE TODAY FOR YOUR COPY OF THE NEW COMPLETE VOLUTEC CATALOG

SCHUCO SCIENTIFIC

DIV. OF SCHUELER & COMPANY / 75 CLIFF ST., NEW YORK 38

Schuco also manufactures MEDI-SPRAYS

27–28. Electron Devices, 6th annual, Washington, D.C. (J. Hornbeck, Bell Telephone Labs., Murray Hill, N.J.)

27–29. American Soc. for Aesthetics, Brooklyn, N.Y. (J. R. Johnson, Cleveland Museum of Art, Cleveland 6, Ohio)

27–29. International Assoc. of Milk and Food Sanitarians, Chicago, Ill. (V. T. Foley, Kansas City, Missouri, Health Dept., 21st Floor, City Hall, Kansas City, Mo.)

28–29. Society for the Scientific Study of Religion, 20th, New York, N.Y. (W. H. Clark, Hartford School of Religious Education, Hartford 5, Conn.)

29–3. Photoelasticity, intern. symp., Chicago, Ill. (P. D. Flynn, ISP, Illinois Inst. of Technology, Chicago 16)

31–2. Association of Military Surgeons of the U.S., Washington, D.C. (R. E. Bitner, Suite 718, New Medical Bldg., 1726 Eye St., NW, Washington)

31–2. Electrical Techniques in Medicine and Biology, 13th annual conf., Washington, D.C. (G. N. Webb, Room 547, CSB, Johns Hopkins Hospital, Baltimore 5, Md.)

31–2. Geochemical Soc., Denver, Colo. (K. B. Krauskopf, Geology Dept., Stanford Univ., Stanford, Calif.)

31–2. Geological Soc. of America, Denver, Colo. (F. Betz, Jr., 419 W. 117 St., New York 27)

31–2. Society of Economic Geologists, Denver, Colo. (H. M. Bannerman, U.S. Geological Survey, Washington 25, D.C.)

31–2. Society of Rheology, annual, Pittsburgh, Pa. (J. H. Dillon, Soc. of Rheology, Textile Research Inst., Princeton, N.J.)

31–4. American Public Health Assoc., San Francisco, Calif. (B. F. Mattison, APHA, 1790 Broadway, New York 19)

November

1–3. International Cong. on Experimental Mechanics, New York, N.Y. (R. Guernsey, Jr., Soc. of Experimental Stress Analysis, General Engineering Lab., General Electric Co., Schenectady 5, N.Y.)

1–16. International Electrochemical Commission, New Delhi, India. (American Standards Assoc., 70 E. 45 St., New York 17)

2–4. Plasma Physics, 2nd annual, Gatlinburg, Tenn. (A. H. Snell, Oak Ridge Natl. Lab., Oak Ridge, Tenn.)

2–4. Society for Experimental Stress Analysis, Berkeley, Calif. (W. W. Murray, Massachusetts Inst. of Technology, Cambridge)

2–5. American Soc. of Parasitologists, Los Angeles, Calif. (F. J. Kruidenier, Zoology Dept., Univ. of Illinois, Urbana)

2–5. American Soc. of Tropical Medicine and Hygiene, Los Angeles, Calif. (R. B. Hill, 3573 St. Gaudens Rd., Miami 33, Fla.)

2-5. American Speech and Hearing Assoc., Los Angeles, Calif. (K. O. Johnson, 1001 Connecticut Ave., NW, Washington 6)

3–4. Electrostatic Propulsion, conf., Monterey, Calif. (J. M. Sellen, Thompson Ramo-Wooldridge, Inc., 8433 Fallbrook Ave., Canoga Park, Calif.)

3–4. Muscle as a Tissue, conf., Philadelphia, Pa. (Division of Research, Lankenau Hospital, Philadelphia 31)

Well, not that simple, but the Baird Atomic Flame Photometer is a breeze for a skilled lab technician.
It is a highly accurate instrument, perfected after years of thorough field testing.

Here's what it is:
An internal standard, double beam flame photometer.

Here's what it does:
Gives direct reading, accurate measurements of K and Na from ONE microsample of serum.

Here's how it does it:
A known concentration of lithium is the standard: light from the lithium emission line falls on the "internal standard" phototube. A second phototube receives the signal from the K or Na line; the *difference* between the two energy signals is indicated on the meter, calibrated directly into milliequivalents per liter of K or Na.

Here's why you should have one in your lab:
You gain speed and reliability, eliminate calculations and references to curves. No errors due to variations in flame or in sample viscosity and pH.

Here's how to learn more:
Ask your Will Representative to show you how the B/A Flame Photometer saves hours of lab time . . . or send for our new 8-page brochure.

Will CORPORATION
and subsidiaries

WILL *Specialists in Scientific Supply*

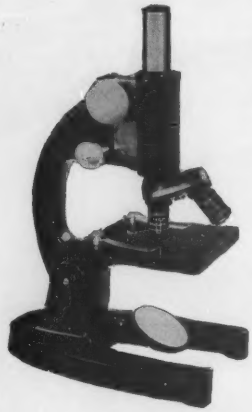
ROCHESTER 3, N.Y. • ATLANTA 1, GA. • NEW YORK 52, N.Y. • BALTIMORE 24, MD.
BUFFALO 5, N.Y. • SO. CHARLESTON 3, W. VA.

TROUBLE FREE

STUDENT MICROSCOPES

GRAF APSCO

CHICAGO, U.S.A.



NEW DESIGN
EXCLUSIVE
SAFETY FEATURES
MEDICAL QUALITY OPTICS
10X OCULAR
OBJECTIVES
16mm (10X) N.A. 0.27
4mm (44X) N.A. 0.66

TRANSPORTATION INCLUDED

Write for catalogue listing safety features

MODEL GB2A

List price ..... $117.00 ea.

Quantities of 5 or more ..... $105.30 ea.

THE GRAF-APSCO CO.

5868 BROADWAY CHICAGO 40, ILL.

TRI-R

Electronic THERMOMETER

THERMISTOR TYPE

- **RAPID . . .** Read temperature in seconds
- **ACCURATE . . .** ±½% of scale range
- **RANGES . . .** From −35 to +150°C.
- **DIRECT READING . . .** In °C. and °F.
- **REMOTE READING . . .** Leads to 1000 feet
- **LOW COST . . .** Priced from $72.00
- **STABLE . . .** Mercury cell battery models, regulated line operated models
- **PROBES . . .** Interchangeable and special for human, animal, laboratory use

For Thermometer bulletin and other Tri-R Instruments write Dept. S96

TRI-R INSTRUMENTS

Developers of Electronic and Mechanical Instruments for Scientific Research

144-13 JAMAICA AVENUE, JAMAICA 35, N.Y.

GAS CHROMATOGRAPHY THE MODULAR WAY

Planning something different in Gas Chromatography? Will your chromatograph let you—without rebuilding, that is?

An RSCo Modular System would.
Plug-in units, you know.

About to go Vapor Phase for the first time?
Going whole hog with a one-unit complete package?

A few RSCo Modules might get you started.
Easy to add more later.

Wish you had a contortionist to change columns and make connections in your chromatograph?

Not supplied with most brands.
Not needed with RSCo Modular Systems.

Does the future worry you? What to do when obsolescence sets in?

RSCo worried for you.
Answer: Built-in expandability.

Is that all for gas chromatography?

Not quite.
That's why we have a 69-page catalog.

Want one?

It's yours, free. Just tell us where you are.

RSCo

RESEARCH SPECIALTIES CO.

200 SOUTH GARRARD BLVD. RICHMOND, CALIFORNIA

4–5. West-Central States Biochemical Conf., Lincoln, Neb. (J. H. Pazur, Dept. of Biochemistry and Nutrition, Univ. of Nebraska, Lincoln)

4–6. Assoc. of Clinical Scientists, Washington, D.C. (R. P. MacFate, 54 W. Hubbard St., Chicago 10, Ill.)

5. Society for Industrial and Applied Mathematics, Philadelphia, Pa. (G. Kaskey, Remington Rand Univac, 1900 W. Allegheny Ave., Philadelphia)

7–10. Society of Exploration Geophysicists, 30th annual intern., Galveston, Tex. (C. C. Campbell, Box 1536, Tulsa, Okla.)

8–10. Forensic Sciences, 2nd symp., Washington, D.C. (Director, Armed Forces Inst. of Pathology, Washington 25)

9–10. Use of Secondary Surfaces for Heat Transfer with Clean Gases, symp., London, England. (Secretary, Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1)

9–11. Clinical Chemistry Methods, symp., Cleveland, Ohio. (A. Hainline, Cleveland Clinic, 2020 E. 93 St., Cleveland 6)

10–12. Geological Soc. of America, 73rd conv., Denver, Colo. (H. R. Aldrich, GSA, 419 W. 117 St., New York 27)

10–12. National Assoc. of Geology Teachers, Denver, Colo. (F. Foote, Dept. of Geology, Williams College, Williamstown, Mass.)

10–13. Pacific Coast Fertility Soc., Las Vegas, Nev. (A. C. Wineberg, 3120 Webster St., Oakland, Calif.)

11–12. Paleontological Soc., Denver, Colo. (H. B. Whittington, Harvard Univ., Cambridge 38, Mass.)

13–16. Society of American Foresters, 60th annual, Washington, D.C. (H. Clapper, SAF, 825 Mills Bldg., Washington 6)

14–17. Magnetism and Magnetic Materials, 6th annual conf., New York, N.Y. (L. R. Bickford, Jr., I.B.M. Research Center, Yorktown Heights, N.Y.)

14–18. American Soc. of Agronomy, Chicago, Ill. (L. G. Monthey, 2702 Monroe St., Madison 5, Wis.)

14–18. Nuclear Ship Propulsion, symp., Taormina, Sicily. (International Atomic Energy Agency, 11 Kärntner Ring, Vienna 1, Austria)

15–16. Engineering Application of Probability and Random Function Theory, symp., Lafayette, Ind. (J. L. Bogdanoff, School of Aeronautical and Engineering Sciences, Purdue Univ., Lafayette)

16–19. Society of Naval Architects and Marine Engineers, annual, New York, N.Y. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6)

17–19. Extrapyramidal System and Neuroleptics, intern. symp., Montreal, Canada. (J.-M. Bordeleau, Dept. of Psychiatry, Univ. of Montreal, Montreal)

17–19. Surgery of Endocrine Organs, symp., New York, N.Y. (Office of the Associate Dean, New York Univ. Post-Graduate Medical School, 550 First Ave., New York 16)

17–20. American Anthropological Assoc., Minneapolis, Minn. (B. J. Meggers, 1530 P St., NW, Washington 5)

17–20. Southern Thoracic Surgical Assoc., Nassau, Bahamas. (H. H. Seiler, 517 Bayshore Blvd., Tampa 6, Fla.)

18–19. American Medical Writers' Assoc., Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

21–23. Fluid Dynamics, annual, Baltimore, Md. (R. J. Emrich, Div. of Fluid Dynamics, APS, Dept. of Physics, Lehigh Univ., Bethlehem, Pa.)

24–25. American Physical Soc., Chicago, Ill. (K. K. Darrow, APS, 538 W. 120 St., New York 27)

24–26. Central Assoc. of Science and Mathematics Teachers, 60th annual conv., Detroit, Mich. (L. A. Conrey, School of Education, Univ. of Michigan, Ann Arbor)

25–26. American Soc. of Animal Production, Chicago, Ill. (C. E. Terrill, Animal Husbandry Research Div., Agricultural Research Center, Beltsville, Md.)

25–26. National Council for Geographic Education, Cincinnati, Ohio. (L. Kenndmer, Univ. of Texas, Austin)

25–16. Bahamas Medical Conf., Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

27–1. Latin American Cong. of Neurology, Santiago, Chile. (R. Nunez, Almirante Montt 485, Dep. 11, Santiago, Chile)

27–2. American Soc. of Mechanical Engineers, annual, New York, N.Y. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

27–5. International Federation of Agricultural Producers, 11th conf., New Delhi, India. (IFAP, 1624 Eye St., NW, Washington 6)

28–1. Entomological Soc. of America, Atlantic City, N.J. (R. H. Nelson, 4603 Calvert Rd., College Park, Md.)

3 NEW COOMBS SERUMS

Anti-γ
Globulin Serum (Rabbit)
Specific for the gamma globulin fraction of human serum. Reacts best with cells that are coated with any of the various antibodies of the Rh system. Particularly useful in Dᵘ testing. Helpful in the study of certain other antibodies, such as anti-K or anti-Fyᵃ.

Anti-γ + Non-γ
Globulin Serum (Goat)
Individual antiserums are selected on the basis of their immunoelectrophoretic behavior and pooled to obtain a reagent of maximum reactivity for both gamma and non-gamma antibodies. Recommended for routine use in all Coombs tests.

Anti-Non-γ
Globulin Serum (Goat)
Reacts with cells coated with antibody which is not gamma globulin. Helpful in the study of antibodies occurring in ABO hemolytic disease, anti-Leᵃ, anti-Leᵇ, anti-Jkᵃ, and some examples of anti-K and anti-Fyᵃ.

Each of the three serums is available in 2 cc dropper vials at $5.50 per vial and 5 cc dropper vials at $11.00 per vial.

Use of the two selective serums (one specific for gamma globulin and the other for non-gamma globulin) is especially helpful in the study of sensitization involving more than one antibody and in which both gamma and non-gamma varieties of antibody occur — for example, sensitization involving both anti-Rh and anti-Jkᵃ.

Hyland
HYLAND LABORATORIES
4501 Colorado Blvd., Los Angeles 39, Calif. / Branch office: 100 Lockwood Ave., Yonkers, N.Y.

CRISIS AT Y.S.I.

! POLICY FIRM !

Never introduce an instrument until it can be built. Obvious statement? At **YSI**, "build" means successful pilot production run—not lab model. Customers get **immediate** delivery. (trade talk meaning 2 to 4 weeks).

◆◆◆◆◆◆◆

DESPERATE MEASURES

Production crews on stand-by basis. (full forty-hour week).

NEW

dual-channel, multiple sensitivity

LABORATORY RECORDER

and & *also*

☆☆☆ **NEW** ☆☆☆

low-priced, multiple range, transistorized

TELETHERMOMETER

Now operating in Laboratory.

Laboratory hates to release! Production department hates laborato-y!! Sales Mgr. frantic, hates everybody.

GRAVE DOUBTS

Management of National Institute of Health Show shaking heads. **YSI** management shaking. Booth space rented. Exhibit built and ready. (Expense accounts ready.)

WILL NEW INSTRUMENTS

BE READY?

Laboratory says "Wellllll"
Production says "If . . ."
Sales Mgr., (nervous smile) says "YES!"*

YELLOW SPRINGS INSTRUMENT CO., INC.
Yellow Springs, Ohio

* stop by and see if we make it.

Booth 88, NIH Show, October 4-7

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. A coupon for use in mailing inquiries concerning the items listed is included in the post card insert. Circle the department number of the items in which you are interested on this coupon.*

■ ANALOG-TO-DIGITAL CONVERTER is a solid-state instrument with a speed of 10,000 conversions per second at accuracy said to be ±0.05 percent. Display is either 11-bit binary or 3-digit binary-coded decimal plus sign. Four decimal digits and sign can also be obtained. Input impedance is 10,000 ohm/volt. (Packard Bell Electronics, Dept. Sci779, 12333 W. Olympic Blvd., Los Angeles 64, Calif.)

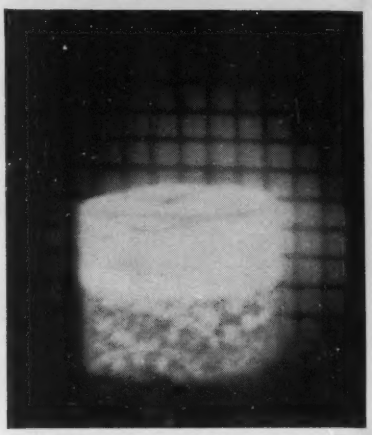
■ SILICON CARBIDE rectifiers are said to withstand temperatures of 500°C and to be one-tenth as subject to radiation damage as silicon. Typical reverse currents are less than 100 μa at 50 volts at 400°C. At 500°C maximum average forward current is 100 ma and maximum peak inverse voltage is 50 or 100 volts. (Transitron Electronic Corp., Dept. Sci780, 168 Albion St., Wakefield, Mass.)

■ OHMMETER measures deviation of resistance from a selected nominal value and displays the result in digital form as a percentage of the nominal value. A range of ±5 percent of total resistance is measured with absolute accuracy said to be ±0.01 percent, the 5-percent range being measured with 3-digit accuracy. Average balancing time is 1 sec. (Electro Instruments Inc., Dept. Sci781, 3540 Aero Court, San Diego 11, Calif.)

■ INFRARED TRANSMITTING GLASS will transmit 77 percent of infrared radiation at 4.0 μ and 38 percent at 5.5 μ in a thickness of 2 mm. Transmission loss at 600°C is 13 percent at 5.5 μ and zero at 4.0 μ. Various shapes and sizes can be mass produced and given an optical finish with standard grinding and polishing techniques. (Corning Glass Works, Dept. Sci789, Corning, N.Y.)

■ VOLTAGE SAMPLER MODULE is designed to follow a rapidly changing voltage wave. It is functionally equivalent to an input operational amplifier connected through a switch to an *RC* filter and followed by a low impedance output amplifier. With the switch closed, the output follows the input in about the same fashion as a 2-μsec delay network. When the switch opens, the voltage is held within 0.05 percent for 1 msec, long enough to be converted to digital form by the manufacturer's converter. (Adage, Dept. Sci791, 292 Main St., Cambridge 42, Mass.)

ISOTOPES
for Your Development Work



Oak Ridge National Laboratory offers more than 300 radioactive and stable isotope products.

RADIOISOTOPES

Processed Solutions—90 processed radioisotopes may be obtained, including many carrier-free and high specific activity products.

Now Available—Iridium-192 gamma sources with specific activity up to 100 curies per gram, and cobalt-60 radiography sources 1/8 and 1/16-inch in diameter with specific activity greater than 100 curies per gram. At a reduced price, carbon-14 barium carbonate is available at $9.50 per millicurie.

STABLE ISOTOPES

More than 200 stable isotopes available from 50 elements. . . . Chemical processing and target fabrication services also offered. . . . Ultra-high isotopic purity in a number of isotopes.

For information or literature, write to: Isotopes Division, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, Tennessee.

ISOTOPES

OAK RIDGE NATIONAL LABORATORY
Operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

■ VIBRATION TEST CHAMBER provides vibration access ports through the bottom and through the sides. A hydraulic lift assembly permits raising or lowering chamber height. Flexible silicone diaphragms seal the ports. Temperature range is −100° to +300°F or +100° to +500°F. Refrigeration system can also be provided. (Conrad Inc., Dept. Sci783, 141 Jefferson St., Holland, Mich.)

■ MOISTURE TESTER is designed for intermittent duty with fast drying. Rapid heating and high static pressure from a high-speed blower are said to achieve rapid moisture determination in sand, ceramics, textiles, and other materials. (Harry W. Dietert Co., Dept. Sci784, 9330 Roselawn Ave., Detroit 41, Mich.)

■ WAVE-GUIDE STAND accommodates all wave-guide sizes used in the frequency range 2.60 to 40.0 kMcy/sec. A continuously adjustable set of jaws grips the sidewalls of the wave guide and simultaneously locates the transmission-line center 3 in. above bench level. (Polytechnic Research & Development Co., Dept. Sci785, 202 Tillary St., Brooklyn, N.Y.)

■ TIME PRINTER ACCESSORY for strip-chart recorders automatically prints date, time to the nearest minute, and a remotely selected identification code number. The time clock operates on 60 cy/sec power, and the printing mechanism can be furnished to operate on 24 to 115 volts a-c or d-c. Up to 12 code numbers are selectable. (Royson Engineering Co., Dept. Sci786, Hatboro, Pa.)

■ GAS ANALYZER monitors carbon dioxide concentration under 2 percent in nitrogen gas streams. A thermal conductivity cell immersed in a thermostatted oil bath is used as detector. Accuracy is said to be better than ±0.05 percent CO_2. (Industrial Instruments Engineering Corp., Dept. Sci787, 89 Commerce Rd., Cedar Grove, Essex County, N.J.)

■ MICRO-FURNACE, manufactured by Reichert, mounted upon the inverted stage of a metallographic microscope, permits observation, photomicrography, and cinephotomicrography of thermal-transition phenomena of metals and their alloys while they are subjected to temperatures ranging to 1600°C. The water-cooled high-vacuum furnace can accommodate specimens approximately ¼ in. in diameter. Temperatures are measured and controlled by means of a thermocouple. The furnace is evacuated to prevent oxidation of the specimen. Heating-up period from room tem-

Lourdes

VACU-FUGE

FIRST...

to SPIN

• 1500 ml. at 60,000xG

• 3300 ml. at 33,000xG

with AUTOMATICALLY CONTROLLED TEMPERATURES down to −20°C

Also spins

800 ml. at 61,500xG

Model VA-2

- Temperature range −20°C to 40°C
- Patented "Roto-Air" refrigeration system
- 1-HP Universal motor
- High-Vacuum pump—evacuates chamber in only two minutes
- 800 ml. (16 x 50 ml.) at 61,500 x G
- Slant-O-Matic control panel
- Fully Automated with push-button operation
- Electro-dynamic brake
- Automatic self-centering drive
- Exclusive Flex-O-Matic rotor support system
- One year warranty

ULTRA SUPERSPEED REFRIGERATED

VACU-FUGE*

with exclusive SLANT-O-MATIC KEYBOARD

**Vacu-Fuge . . . a coined name by Lourdes Instrument Corp., denoting superspeed centrifuges operating under vacuum.*

The most versatile, superspeed vacuum centrifuge ever offered. Accommodates six interchangeable rotors. Designed for large or small volume, high or low force centrifugation. New patented refrigeration design and other exclusive features give performance that far exceeds anything previously available. Write today for Bulletin VA-2.

VA-2 speeds your work safely and dependably. Built for years of rugged service.

MAIL COUPON TODAY

LOURDES INSTRUMENT CORP., Div. of Labline, Inc., 53rd St. & First Ave., Brooklyn 32, N.Y.

Please send me VACU-FUGE Bulletin VA-2 Dept. SC-90

BE SURE... CHOOSE LOURDES

Name _____

Title _____

Activity _____

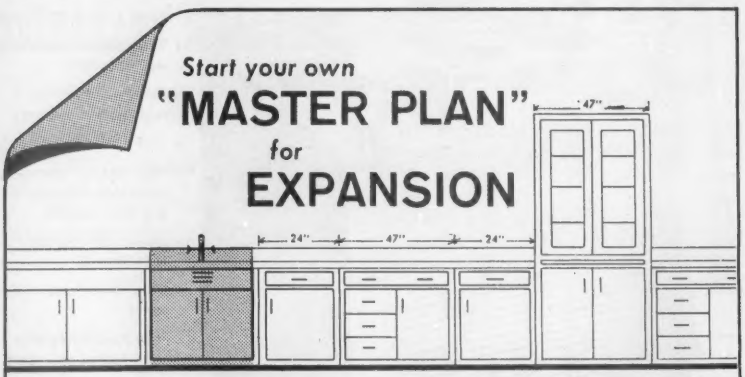
Address _____

City _____ Zone ____ State _____

perature to 1600°C is approximately 2 min. Cooling-off time to 200°C is approximately 15 to 30 sec. (William J. Hacker and Co., Dept. Sci790, P.O. Box 646, West Caldwell, N.J.)

■ CLEANING SYSTEM mounts parts to be cleaned on the periphery of a rotary turntable and automatically indexes to successive high-velocity spray-cleaning operations. Solvent and heated, filtered air are directed against all areas of the part. The solvent used is said to be completely free of all nonvolatile materials. (Cobehn Inc., Dept. Sci799, Passaic Ave., Caldwell, N.J.)

■ THERMAL IMPEDANCE MEASURING EQUIPMENT uses pulse technique to measure junction thermal impedance. The junction is heated with d-c power which is pulsed off for 500 μsec at a rate of 10 pulses per second. During the "off" interval, forward voltage drop is measured and compared with the initial drop, the difference yielding the temperature rise. The quotient of temperature rise and applied heating power is defined as thermal impedance. Heating currents up to 50 amp are available. (Wallson Associates, Dept. Sci794, 912-914 Westfield Ave., Elizabeth, N.J.)



with LABASCO flexiplan LABORATORY FURNITURE

A problem well defined is a problem half solved! A LABASCO planning kit solves half the problem of furnishing your laboratory. The acquisition of a new LABASCO unit can be an end in itself or the initial stage in a well-defined "MASTER PLAN" for economical laboratory expansion.

For example a LABASCO Sink Cabinet! Like all the other sturdy, super-efficient LABASCO sectional units, its correct working height, with roomy storage space and resistant work areas are geared for the laboratory of tomorrow. Includes a one piece molded, gray-glazed, chemical porcelain sink bowl, hot and cold water mixing gooseneck faucet, lead drain, trap and overflow.

(Cat. No. L-250 — $230)

- BASE CABINETS
- CORNER CABINETS
- SINK CABINETS
- WALL CABINETS
- BENCH UNITS
- FUME HOODS
- LAB TABLES
- LAB CABINETS
- CHAIRS — STOOLS
- FIXTURES

Write for free catalog with "Do-It-Yourself" Planning Kit to help you visualize your laboratory as you plan it.

ORDER FROM THE LABASCO SUPPLIER IN YOUR AREA

SERVING YOU THROUGH LABASCO NATIONWIDE NETWORK OF LABORATORY EQUIPMENT SUPPLIERS

In the Carolinas:
CARDINAL PRODUCTS, INC.
P.O. Box 1611, Durham, N. C.

In the Ohio Area:
CHEMICAL RUBBER CO.
2310 Superior Ave., Cleveland 14, O.

In the New England Area:
MACALASTER BICKNELL CO.
243 Broadway, Cambridge, Mass.

In the West Virginia Area:
B. PREISER COMPANY
416 W. Washington St.,
Charleston 2, W. Va.

In the Illinois Area:
SCHAAR & COMPANY
7300 W. Montrose Ave.,
Chicago 34, Ill.

In the New York Area:
STANDARD SCIENTIFIC SUPPLY CORP.
808 Broadway, New York 3, N. Y.

■ CAPILLARY GLASS TUBING is available in sizes ranging from 0.0015 to 0.014 in. outside diameter. Tolerances on the capillaries are said to be held to ±0.0002 in. The tubing is offered in standard flint, noncorrosive flint, lead, and heat-resistant glass. Standard length is 6 ft. (Friedrich & Dimmock, Dept. Sci800, Millville, N.J.)

■ CHARACTER GENERATOR is said to generate numbers, characters, and symbols with the quality of fine printing. The output is displayed on a cathode-ray-tube screen. Characters with 5000 television-picture elements of resolution may be generated at a rate of 1000 per second. As many as 5000 individual characters are utilized. A display rate of 100,000 characters per second can be achieved with 150 different characters, each with 100 television picture elements. The generator uses a word-oriented, wired program memory of ferrite cores to store the character shapes. The system, composed entirely of solid-state components, requires less than 2 ft^3 of space. (Columbia Broadcasting System, Dept. Sci792, 485 Madison Ave., New York 22, N.Y.)

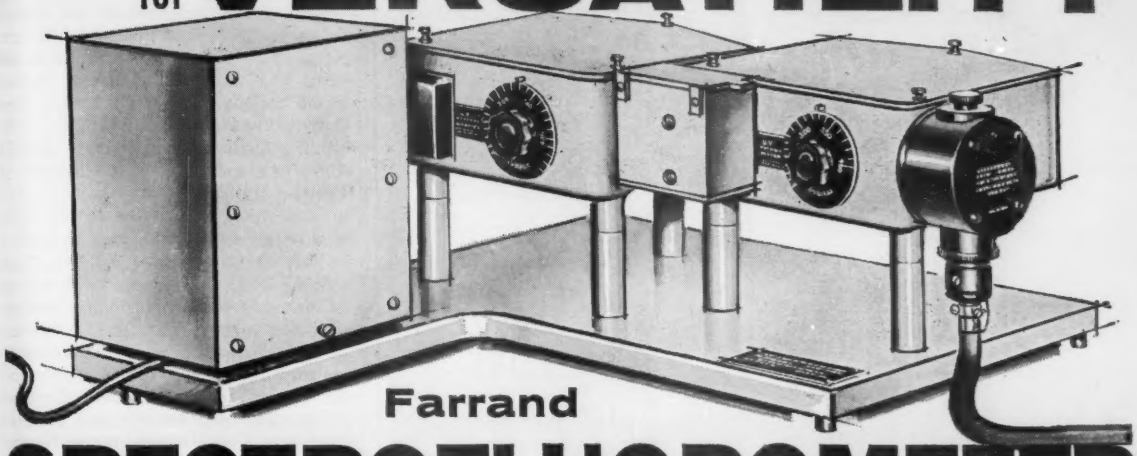
■ POLARIZED MOTOR is a d-c motor without commutator. It is activated by synchronous impulses from a solid-state sealed circuit. Starting torque is 4-in.-lb, and running torque at 1 rev/min is 8 in.-lb. Starting current and running current are both 85 ma at 28 volts d-c. Stopping time is 10 msec. Size is 1⅜ in. in diameter by 2½ in. long, and weight is 12 oz. (Cook Electric Co., Dept. Sci793, 2700 N. Southport Ave., Chicago 14, Ill.)

■ VOLTAGE CALIBRATOR covers the frequency range of 1 kcy to 200 Mcy/sec. Calibrating voltages between 0.001 and 1 volt r.m.s. are provided with 1-volt input. Accuracy at 1-volt input and output is said to be ±1 percent from 1 kcy to 10 Mcy/sec, ±2 percent to 50 Mcy/sec, and ±3 percent to 200 Mcy/sec. Input impedance is 50 ohms. (Kay Electric Co., Dept. Sci796, 14 Maple Ave., Pine Brook, N.J.)

■ OPTICAL LENS BENCH includes two end supports carrying two steel bars spaced 4 in. apart and a third bar below. Three sliders, each with vertical rod and collar, a long "V", a short "V", and a circular platform are furnished as standard equipment. Sliders may be removed or placed at any time. (Mason Instrument Co., Dept. Sci802, P.O. Box 1681, New York, N.Y.)

■ HALL EFFECT MULTIPLIERS are designed for applications requiring high output voltage. The core material used can be driven to linear flux densities well over 10 kgauss. Five models,

unequalled for **VERSATILITY**



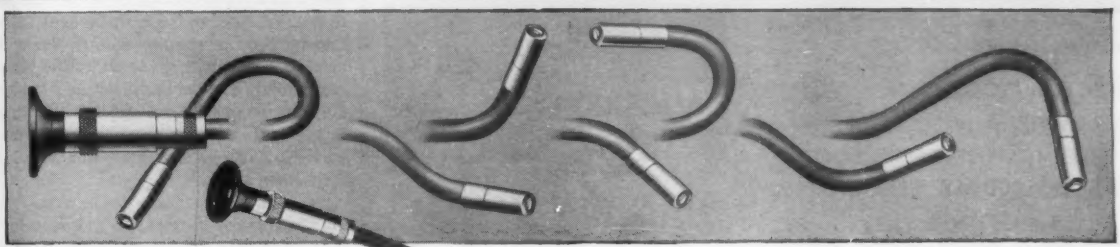
Farrand

SPECTROFLUOROMETER

Versatile instrument for photo-fluorometric assay, identification and analysis of chemical constituents in the Ultraviolet, Visible and Infrared. Measurements are much more discriminating than obtained through colorimetric or spectrophotometric methods. Can be used for micro or macro volumes. Models for manual, oscilloscope or chart recording available.

Technical data available on request
specify Bulletin No. 820S

FARRAND OPTICAL CO., INC.
BRONX BLVD. AND EAST 238th STREET • NEW YORK 70, N. Y.
Engineering, Research, Development, Design and Manufacture of Precision Optics, Electronic and Scientific Instruments



Focusing eyepiece for convenience of user.

For the ultimate in precision viewing of intricate, hard-to-reach areas . . .

A.C.M.I. Fiber Optic *Flexible* Borescopes

FOR visualization in inaccessible curved areas where a flexible instrument capable of adapting itself to irregular contours is required.

Fiber Optic Borescopes are equipped with focusing eyepiece and fixed or movable objective as required. Illumination can be provided by a flexible fiber optic light carrier with an external light source or an annular fiber optic light carrier attached to the image carrier. Fiber optic light carriers are particularly advantageous for transmission of intense cold light to inaccessible or hazardous areas.

Please send details and sketch of your requirements.

AMERICAN CYSTOSCOPE MAKERS, Inc.

8 Pelham Parkway, Pelham Manor (Pelham), N. Y.

New—romicron ATTACHMENT

with

POLAROID LAND CAMERA BACK 2½ X 3¼

for

BAUSCH & LOMB MODEL N

BEAMSPLITTER MICRO CAMERA

- COMPACT
- EASY TO OPERATE
- PICTURE IN ONE MINUTE

Write Today for BROCHURE #962

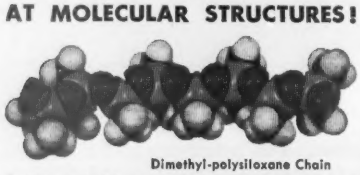
PAUL ROSENTHAL

505 Fifth Avenue New York 17, N. Y.

"POLAROID" ® by Polarold Corp.

Trans-Dichloroethane

THESE SCALE MODELS PROVIDE A VIVID, THREE-DIMENSIONAL LOOK AT MOLECULAR STRUCTURES!



Dimethyl-polysiloxane Chain

LaPine-Leybold atom models according to Stuart and Briegleb have outstanding advantages. They are large. Measurement, assembly and visualization of molecular models are easy, quick. They give an exact picture of the spatial arrangement of organic compounds magnified by 1.5×10^8.

Models snap together quickly. Spring metal wedges make rigid connections for multiple bonds. The "hydrogen-bridge" uses a hook-and-eye connection that enables larger angle shifts and permits the construction of strongly bound, hydrogen-bridged molecules.

No. S 302-80 Initial Set of 84 pieces of 11 types of Atom Models, each $105.00

No. S 302.81 Supplementary Set of 40 pieces of 13 Different Types, each . . . . . $ 58.30

LAPINE

Write for full color brochures.

ARTHUR S. LaPINE AND COMPANY

6001 South Knox Avenue • Chicago 29, Ill.

NOW! *Pumpett* AUTOMATIC PIPETTE CONTROL

FITS ALL PIPETTE SIZES

EASILY CLEANED

SAFELY FILLED! *ONE-HAND OPERATION*

The New PUMPETT offers a simple, safe, micro-controlled method of filling and emptying pipettes. Filling is faster because the operator observes the rising liquid and maintains instant control.

Micro discharge is accomplished with an internal bulb. Accuracy is so high that, in many cases, expensive burettes can be eliminated.

A lever-operated, spring-loaded, two-jaw chuck accommodates all sizes of pipettes, including micro capillary. The complete cycle of operations may be carried out without touching the pipette.

Complete dismantling allows positive cleaning not possible with other equipment.

Use this number when ordering:

S 341-03 Pumpett, each . . $8.90

LAPINE

ARTHUR S. LaPINE and COMPANY

6001 South Knox Ave. • Chicago 29, Illinois

MC 1, 2, 3, 4, and 5, provide a range of coil currents and inductances. Linearity can be optimized by selection of proper load resistance, about 7 ohms. Linearity is determined by power losses in the device. Typical values are: 5 ma, 0.4 percent; 250 ma, 0.1 percent; 125 ma, 0.025 percent. Typical input impedance is 1.2 ohms; typical output impedance is 0.8 ohm. (Ohio Semiconductors Inc., Dept. Sci795, 1205 Chesapeake Ave., Columbus 12, Ohio)

■ ELECTRON-BEAM FURNACE is said to be capable of melting, alloying, and refining ingots of up to 50 lb of tantalum and of proportionate weights of other metals. The furnace consists of two separate chambers, one containing the electron gun, the other the mold and metal-feeding mechanism. Separate pumps are used to evacuate the two chambers. The electron gun is focused by a magnetic coil. The main power supply is a 60-kw unit delivering up to 3 amp at voltages to 20,000. It is interlocked with vacuum gages, pumps, and cooling water to prevent damaging operation. (NRC Equipment Corp., Dept. Sci797, 160 Charlemont St., Newton 61, Mass.)

■ ELECTRONIC COMMUTATORS are solid-state devices that can sample low-level differential instruments such as strain gages and thermocouples at a rate up to 10,000/sec and accuracy said to be ±1 percent or better of full scale at levels of 5 mv or greater. The units contain up to 90 channels. A 30-channel unit weighs 2.5 oz and has less than 1 in.^{3} volume per channel. (General Devices Inc., Dept. Sci803, P.O. Box 253, Princeton, N.J.)

■ RUGGEDIZED TELEVISION SYSTEM consists of a camera and camera control capable of being operated up to 2000 ft apart. No additional housing is required for the camera to operate in all environments in which the equipment could be used. The system will operate at temperatures from −20° to +160°F, in ambient noise levels of more than 185 db, and with no limit on altitude. The system has transistor circuitry exclusively. An automatic light-level compensator adjusts for light-level changes over a 2000-to-1 range. A wide variety of accessories is available. (Thompson Ramo Wooldridge Inc., Dept. Sci810, Michigan City, Ind.)

■ MIXER of rotary type uses a mixing chamber of transparent plastic. Dimensions of the chamber are 6.5 in. in diameter by 12 in. long. The chamber rotates in two changing planes to insure completeness of mixing. (Testing Machines, Inc., Dept. Sci811, 72 Jericho Turnpike, Mineola, N.Y.)

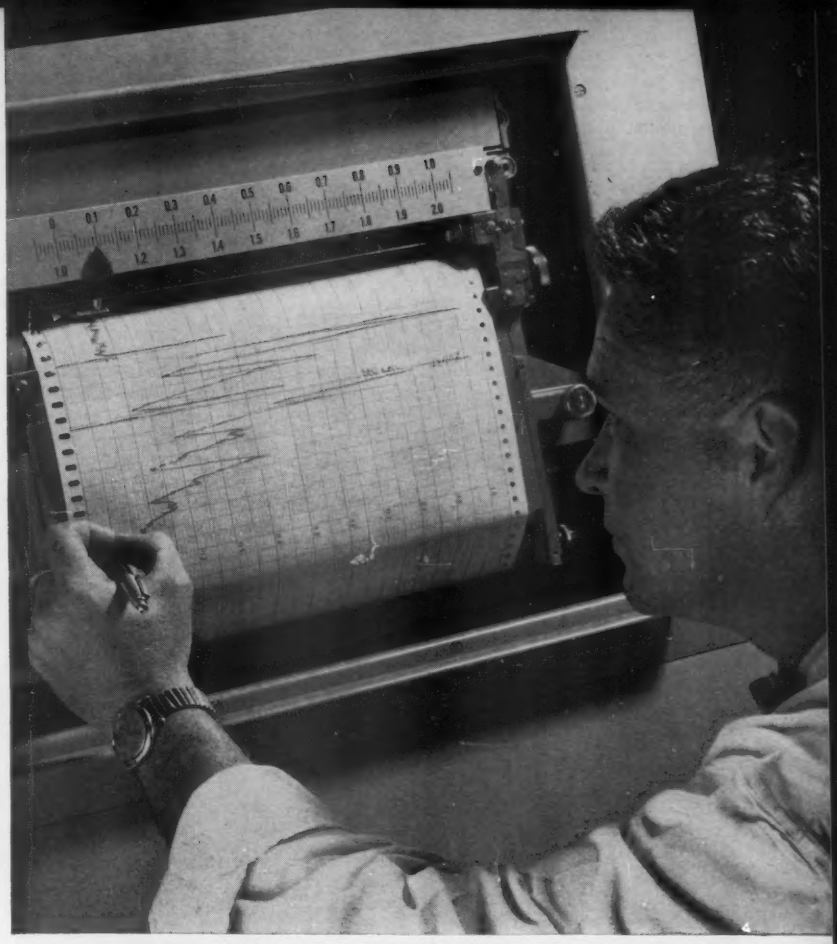
■ THERMOSTAT BATHS, one for thermometer calibration and another for viscometry, have transparent sides. Temperature range is up to 230°C. A circulating plate is said to permit control of temperature fluctuations in the working space within ±0.001°C for water and ±0.005°C for oil. An auxiliary thermostat keeps the emergent stem of the contact thermometer at constant temperature and permits micrometric adjustment of temperature. The units are constructed of stainless steel with transparent areas 22.5 by 10.5 in. and 12.5 by 10.5 in., respectively, for the thermometer calibration bath and the viscometer bath. (Instrumentenfabriek P.M., Dept. Sci816, Tamson N.V., The Hague, Netherlands)

■ AUTOMATIC PLOTTER has a working area that measures 47.25 by 47.25 in. Maximum operating speed in 3 in./sec, and slowest operating speed is 0.003 in./sec. Accuracy is said to be ±0.0015 in. Input may be in the form of tape or cards. Position of *X* and *Y* rails is shown by a projection-type display. An optical line-following device is offered as an accessory. A Flexowriter is used to provide keyboard input, punching of tape, reading of tape, and typing of printed record. (Aero Service Corp., Dept. Sci806, 210 East Courtland St., Philadelphia 20, Pa.)

■ STRETCHABLE CABLE is constructed with a rubber core with insulation of nylon and conductors of copper wire, bronze tinsel, or copper tinsel. A natural rubber core is used in commercial types; military types have a silicone rubber core. Elongation of the former is 300 percent for single-conductor cable and 275 percent for multiple-conductor cable. Corresponding elongations of the military types are 250 and 225 percent. (National Radio Co., Dept. Sci807, Malden, Mass.)

■ LEVELING BASE for a variety of instruments uses three leveling screws mounted at the corners of a triangular platform. A circular level, mounted at one corner, guides adjustment. (W. & L. E. Gurley, Dept. Sci826, Troy, N.Y.)

■ PRESSURE TRANSDUCER uses as sensitive element a free-edged circular diaphragm of Ni-Span-C that forms the movable common plate between two capacitor plates. Pressure change is measured by change in capacitance. Hysteresis effects are said to be less than 0.03 percent and sensitivity better than 0.01 percent of full scale. Full scale ranges are available from 1 to 100 lb/in.^{2} First resonance of an altimeter using the transducer is greater than 1650 cy/sec, and time constant is 0.004



Cary Spectrophotometers
measure reliably at high absorbances
where effects of many sources
of error are minimized

Many materials such as high density filters, solutions which cannot be diluted, etc., *must* be measured at high absorbance. In many instances, such a technique should be *chosen* because of important advantages it offers; it reduces errors which affect the zero line such as those caused by contamination of cell windows, slight shifts in cell positions, etc.; it makes possible fewer dilutions and allows use of more accurate, convenient and inexpensive longer path cells.

Cary spectrophotometers provide several advantages for high absorbance measurements. The low stray light of their double monochromators allows accurate, direct readings for most problems. Their high light gathering power, stable and sensitive photometers, and intense sources give good relative freedom from random noise limitations. Both the Model 11 and Model 14 spectrophotometers are capable of *directly* measuring absorbance values up to 2 or more; with reference beam attenuation they can accurately measure absorbances of 4 or more over most of their ranges. For measurements of this type, special neutral density screens are available for use as convenient and reproducible beam attenuators. (These screens are also valuable as precise secondary standards of absorbance for verification of photometric reproducibility.)

In addition to making high absorbance measurements, Cary spectrophotometers offer unique benefits for a wide variety of problems. For information, write for data file E 18-90

Cary
INSTRUMENTS

APPLIED PHYSICS CORPORATION • 2724 So. Peck Rd., Monrovia, Calif.

sec for 63-percent response. Operating temperature range is −55° to +100°C. (Rosemount Engineering Co., Dept. Sci825, 4900 W. 78 St., Minneapolis 24, Minn.)

■ OPTICAL BENCH with three slides is offered with standard optical accessories such as carriers for center and side slides, micrometer centering carriers, concentric ring sets, lens chucks and lamphouses. The main bench is equipped to mount an auxiliary bench, machined and scaled exactly as the main bench, at right angles to the main bench when systems involving beam splitters are being tested. The auxiliary bench is 21 in. long. (Ealing Corp., Dept. Sci804, 33 University Rd., Cambridge 38, Mass.)

■ CLINOMETER ACCESSORY that adapts a precision clinometer for use in a vertical position consists of a special base, with adjustments for making the axis of rotation of the circle normal to the supporting surface, and a 4.75-in.-diameter work table for measurement of angular displacement of small parts. The clinometer is available in 10-sec and 1-sec sensitivities. (Engis Equipment Co., Dept. Sci805, 431 South Dearborn St., Chicago 5, Ill.)

■ DIGITAL CONTROL SYSTEM is continously slaved to the instructions from user-supplied equipment and will continuously supply the signals necessary to position an encoder to the point where the encoder data are coincident with the three-decimal-digit destination supplied by the user. The system will supply a stop command when the encoder and destination signal are coincident, and sign-of-the-difference signals to assure proper direction-of-rotation commands. (Datex Corp., Dept. Sci819, 1307 S. Myrtle Ave., Monrovia, Calif.)

■ PNEUMATIC CONTROLLERS are available in models for proportional control, with 1-to-400 percent proportional band, and reset control with a rate of 0.1 to 50 repeats per minute. They are offered for control of pressure from vacuum to 10,000 lb/in.^{2}; temperature from −100° to +1000° F; flow and differential pressure; humidity from 0 to 100 percent, relative; and differential liquid level. The frequency response curve is essentially flat to 400 cy/min for proportional control and 325 cy/min for proportional plus reset. (Bristol Co., Dept. Sci817, Waterbury, Conn.)

■ PEN MOTOR for 40-mm recording systems provides rectilinear motion. An interchangeable electric stylus is available. The following specifications are cited when used with the manufacturer's Model DC-101 compensated driver amplifier: coil resistance, 16 ohms; d-c current sensitivity, 28 ma/mm; linearity, 2 percent of full scale; frequency response, d-c to 120 cy/sec (3 db down); damping, approximately 30 percent of critical. An auxiliary winding provides velocity voltage feedback. (Massa Division, Cohu Electronics, Dept. Sci801, 5 Fottler Rd., Hingham, Mass.)

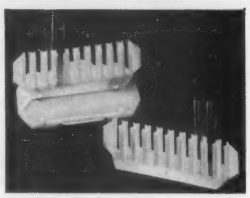
■ VACUUM FURNACE is a continuous firing furnace in which work boats are moved through individual stages, including the firing chamber. Pressure in the latter can be maintained as low as 0.01 μ-Hg continuously. Temperature of the heat zone is continuously adjustable. Various sizes are available. (Kahle Engineering Co., Dept. Sci815, 3322 Hudson Ave., Union City, N.J.)

■ TEMPERATURE CONTROLS are transistorized instruments using thermistor sensing elements. The series 536 that covers the range −50° to +600°C with sensitivity 0.3°F is furnished with either on-off or proportional action and with optional indicator circuit. Also available are similar instruments that function as indicators only. (Fenwal Inc., Dept. Sci824, Pleasant St., Ashland, Mass.)

■ ELECTRON-BEAM EVAPORATING UNIT, for installation in laboratory or commercial vacuum equipment operating at 3×10^{-4} mm-Hg or lower, is capable of vaporizing all metals. The unit includes an electron-beam gun, extra filaments, power supply, control panel, and electrical feed-throughs. Beam-

Neatest little test tube rack you've ever seen!

Nalgene® laboratory plastic ...unbreakable, acid-proof, outlasts metal or wood!



New lightweight Nalgene plastic test tube rack stands free, or in 2-unit or 4-unit plastic base.

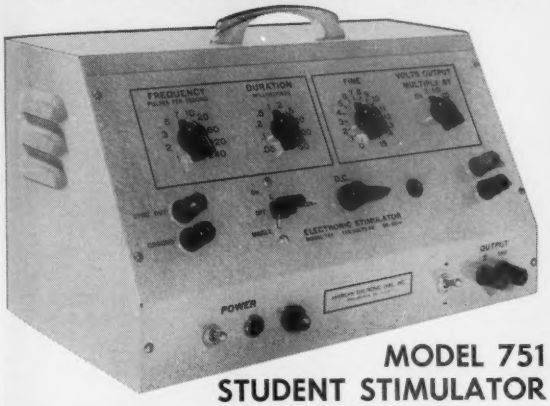
Here is the unique new test tube rack, of Italian design, that outlasts them all. It's the *only holder that lets you see the contents of each tube from top to bottom.* Plastic fingers hold tubes securely; unit fits shaking machines. Nalgene plastic throughout—chemically inert, easy to clean, immersible in water baths, withstands 120° C. Try a few in your lab. You'll like them.

WRITE for Catalog Sheet N-11, Dept. 159

THE NALGE CO. INC. ROCHESTER 2, NEW YORK
Today's Most Complete Line of Plastic Laboratory Ware

BUY AEL EQUIPMENT

AND BE SURE THE PROBLEMS YOU GIVE YOUR STUDENTS ARE NOT THE INSTRUMENTS THEY USE



MODEL 751 STUDENT STIMULATOR

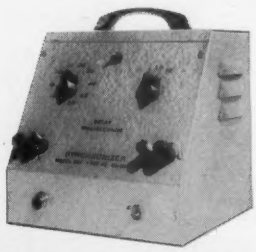
Simple to operate with accurately repeatable frequency and duration controls.
Many uses in physiological labs as well as in the classroom.

Wide ranges—frequency 1 to 240 stimuli per second
duration 0.05 to 50 milliseconds
output 0 to 150 volts

Other features include *signal magnet output*, output sync pulse for use with an oscilloscope, DC stimulus. Quantity discounts for outfitting entire classrooms or student labs.

Accessory for dual pulse stimulation

MODEL 951



AEL DUAL PULSE SYNCHRONIZER

This accessory enables two 751 stimulators to be operated together to produce a pair of pulses with a variable delay from 0.5 to 500 milliseconds.

AEL OFFERS RUGGED, QUALITY INSTRUMENTS FOR STUDENT USE

•

PRECISION ELECTRONIC EQUIPMENT AT BUDGET PRICES

AEL

AMERICAN ELECTRONIC LABS., INC.
121 North 7th Street, Philadelphia 6, Pa. Walnut 5-8780

WARING'S EXPLOSION - PROOF BLENDOR® BASE FOR USE IN ALL HAZARDOUS LOCATIONS*

MODEL EP-1

Introduced recently, Waring's new Explosion-Proof Blendor Base already has been recognized by safety committees throughout the country as the answer to safely blending materials at high speed wherever hazardous atmospheres exist. *Exposed motor arcing is completely eliminated.* Even the most critical blending operations may now be performed with safety in areas that are permeated with flammable gases or vapors likely to produce explosive or ignitible mixtures. No wonder this exclusive Waring Explosion-Proof Blendor Base has had wide, enthusiastic acceptance in the chemical, petroleum and other industries!

SPECIFICATIONS: Lifetime-lubricated motor is wired for 2 speeds; ⅓ H. P.; 120 volts; AC-DC; 25-60 cycles; 4.2 amps. Stainless steel container (shown) or Pyrex container, both with 37½-ounce capacity, may be used.
**Class I—Group D Rating*

WARING PRODUCTS CORPORATION

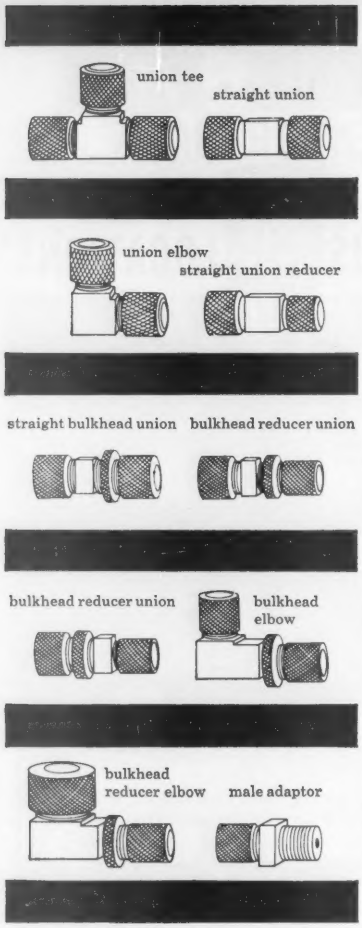
25 West 43rd Street, New York 36, N. Y.
A subsidiary of Dynamics Corporation of America

NAME YOUR BLENDING PROBLEM
Waring Engineers will help you solve it.

SEND FOR FREE LITERATURE

GENTLEMEN:
I want full specification data on the new Explosion-Proof Waring Laboratory Blendor Base.

NAME.....
TITLE.....
COMPANY.....
ADDRESS.....
CITY/ZONE.....STATE.....



simplify tubing connections with Vari-Grip* Teflon Fittings

No need to labor over glass ball joints or other intricate fittings or connectors with the new Beckman Vari-Grip* Teflon Tube Fittings. Simply insert glass or metal tubing into fitting and tighten nut for a perfect compression seal. Fitting design permits considerable variation in tube size. Since Teflon is more inert than glass it is unaffected by most liquids and gases. ⊠ A complete listing of time-saving Beckman Vari-Grip Fittings by size, type, and price is available from authorized Beckman laboratory apparatus dealers. Or write for Data File 38-39-09

Beckman *Scientific and Process Instruments Division*
Beckman Instruments, Inc. 2500 Fullerton Road, Fullerton, California

INSTRUMENTAL IN YOUR FUTURE 25 YEARS 1935-1960

*TRADEMARK, BI
826

current rating is 250 ma at 10 kv. Optional accessories include a 1000-volt bias supply and a motor-driven feed to supply evaporating metals continuously to the vapor source. Operation is on 120-volt, 60-cy/sec power. (Alloyed Corp., Dept. Sci818, 35 Cambridge Parkway, Cambridge 42, Mass.)

■ ATOMIC FREQUENCY STANDARD for airborne applications weighs 65 lb and has a volume less than ½ ft^3. Frequency stability is said to be better than 1 part in 10^9 for the life of the equipment under environmental conditions in aircraft operations. (National Co., Dept. Sci808, Malden, Mass.)

■ SURFACE-TENSION MEASURING INSTRUMENT uses the du Noüy method of measuring pull on a ring with semiautomatic operation. The torsion wire that moves the test ring is twisted at a slow, uniform rate by a reversible synchronous motor. At the moment the ring breaks free of the surface, the support arm touches a contact and a relay stops the motor. The applied torsion is indicated on a scale calibrated from 0 to 90 dyne/cm. (Fisher Scientific Co., Dept. Sci821, 717 Forbes St., Pittsburgh 19, Pa.)

■ MICROWAVE OSCILLATOR features plug-in generator heads in standard steps of 1 to 2, 2 to 4, 4 to 8, 8 to 12.4, 6.5 to 11.5, and 12.4 to 18 kMcy/sec. Sweep frequency is continuously adjustable from 0 to band-width extremes. Two adjustable frequency markers are provided. Residual FM is ±0.0025 percent, and drift is ±0.02 percent. (Alfred Electronics, Dept. Sci822, 897 Commercial St., Palo Alto, Calif.)

■ LENSES for image intensifiers form images on a surface of 4.00-in. radius of curvature convex to the objective. They are corrected for 16:1 and 4:1 conjugates. Aperture is $f/0.87$. Used in pairs, the lenses are utilized for 1:1 magnification coupling between the flat phosphor of one image tube and the convex cathode of the next tube, covering a 1-in. diameter field. (Farrand Optical Co., Dept. Sci823, Bronx Blvd. and E. 238 St., New York, N.Y.)

■ SIGNAL GENERATOR uses a separate crystal-controlled oscillator-amplifier to generate each of 50 fixed frequencies in the range from 50 kcy to 900 Mcy/sec. The individual units are packaged in groups of ten and are selected by switches. Output is held to a constant level independent of frequency. Attenuation up to 110 db is provided in 1-db steps. Frequency stability of 5×10^{-7}/wk is said to be achievable. Frequency multiplying circuits are used above 75 Mcy/sec. (Telonic Industries, Dept. Sci827, Beech Grove, Ind.)

This One E-A EVENT RECORDER

does more work than 20 STOP WATCHES

Each of the 20 pens, writing on a moving, time-calibrated chart can give you split-second, stop watch timing of individual events.

In addition, the time relationships of the events are also recorded. With an E-A Event Recorder, you can have a permanent, indisputable record of such things as:

- **Productive and idle time.**
- **Flow of materials.**
- **Position of gates and dampers.**
- **Time of failure in destruction tests.**
- **Sequence of switching as in —appliance control testing, —electrical substation monitoring, —missile firing.**

You save time and costs with these versatile recorders which "picture" both sequence and duration of events—in production and processing . . . in research . . . in plant safety.

Send for Catalog Section 50 for full information.

The ESTERLINE-ANGUS Company

No. 1 in fine Recording Instruments for more than 50 years

DEPT. L, BOX 596, INDIANAPOLIS 6, INDIANA

▪ PUMP of peristaltic type accommodates hoses of any size up to 1 in. Flow is variable from a few milliliters per minute to nearly 500 gal/hr. A reversing switch permits flow in either direction. Delivery per revolution is said to be constant enough for metering applications. (Schueler & Co., Dept. Sci828, 75 Cliff St., New York 38, N.Y.)

▪ CENTRIFUGE is said to show long-term drift less than 1 part per million per week. Deviation from average angular velocity is specified as less than 1 part in 50,000. Range is 0.5 to 20 grav. Angular velocity is adjustable in 60 discrete steps measured by a magnetic pulse system and electronic counter. Capacity is 25 lb in a 12-in. cube. A radius comparator measures any variation in arm radius as a function of speed. (Genisco Inc., Dept. Sci829, 2233 Federal Ave., Los Angeles, Calif.)

▪ TEST TABLE for gyros and gyro systems weighing up to 150 lb is a servo-driven, two-axis instrument. Constant rates between 0.15 deg/hr and 1200 deg/sec are available. Up to 24 circuit slip-ring and brush-block assemblies can be provided for each axis. Units are available with inductive type angular pickoffs said to be precise to ±3 sec. (Power-Tronic Systems, Dept. Sci831, 10 Pine St., New Rochelle, N.Y.)

▪ AIR POLLUTION TESTER is a compact portable apparatus for air pollution testing in emergency or preliminary field work. The unit employs a colorimeter to estimate amounts of eight gaseous pollutants and can also be used to indicate presence of ten particulate pollutants. The tests are made by a train of reagents and color solutions through which the air is pumped. The colors developed are compared against color standards which have been previously calibrated in terms of micrograms of pollutants per cubic foot. (Central Scientific Co., Dept. Sci834, 1700 Irving Park Rd., Chicago, Ill.)

▪ NEUTRON ACTIVATOR provides a source of 14 Mev neutrons with a time average output of 10^8 neutrons/sec at a rate of 100 pulses per second and pulse duration 5 μsec. Neutrons are produced by the reaction of deuterium and tritium. Neutron output can be varied by adjustment of either the voltage used to accelerate the deuterons or the pulse rate. A control cabinet permits remote operation of the source. The activator is shipped ready for operation. (Radiation Counter Laboratories, Dept. Sci837, Nucleonic Park, Skokie, Ill.)

JOSHUA STERN

National Bureau of Standards, Washington, D.C.

now, at low cost, the new ASCO "50" enables you to compare your present processing costs with those of

MOLECULAR DISTILLATION

Fields of investigation heretofore made prohibitive through use of highly expensive investigative techniques can now be explored with this simple-to-operate molecular still. Since the "50" still is the laboratory counterpart of the large commercial Rota-Film Still, results obtained may be duplicated on a commercial scale of any magnitude.

With this simple-to-operate still you may...

• explore falling agitated film evaporation and distillation • distill materials with molecular weights ranging from 200 to 1250 weight (hydrocarbons) and some materials to 4000 molecular weight (silicones and halocarbons) • deglycerinate and distill mixtures of mono-, di- and tri-glycerides • distill tall oil • distill paraffin from slack wax or petroleum residue • deodorize oils • remove color bodies from materials of high molecular weights.

FEATURES

- Batches from 10 ml to 20 liters
- Vacuum range from atmospheric to 1 micron Hg.
- Temperature range to 450°C.
- Teflon or carbon rotor-wiper blades
- Stainless-steel (18-8 type 304) wiper-holders (Available with Hastelloy B)
- Continuous or batch feed
- All parts made of glass except wiper-holders and top plate
- UNITS MAY BE COUPLED FOR FRACTIONATION.

a|s c|o ARTHUR F. SMITH, INC. • 311 ALEXANDER ST., ROCHESTER 4, N. Y.

California Science Books

▪ **TABLES RELATED TO RADIATION EMERGING FROM A PLANETARY ATMOSPHERE WITH RAYLEIGH SCATTERING**

By Kinsell L. Coulson, Jitendra V. Dave, and Zdenek Sekera. Designed to simplify the means of extracting the intensity, the degree of polarization, and the orientation of the plane of polarization diffusely reflected or transmitted in any direction for different sun elevations, and for different values of ground reflectivity. $12.50

▪ **GEOCHEMICAL METHODS OF PROSPECTING AND EXPLORATION FOR PETROLEUM AND NATURAL GAS**

By A. A. Kartsev, and others. . . $12.50

▪ **BASIC PROCESSES OF GASEOUS ELECTRONICS**

By Leonard B. Loeb.
(2nd printing 1960) $13.50

▪ **THE GULF STREAM: Its Physical Nature and Dynamical Description**

By Henry Stommel.
(2nd printing 1960) $6.00

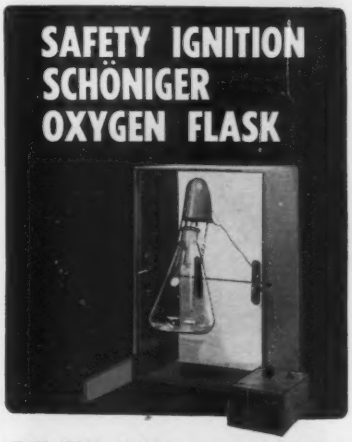
▪ **VALUE AND PLAN: Economic Calculation and Organization in Eastern Europe**

Edited by Gregory Grossman. A symposium on post-Stalinist economic developments $7.00

At your bookseller or

University of California Press/Berkeley 4

SAFETY IGNITION SCHÖNIGER OXYGEN FLASK



THE F&M MODEL 141 SAFETY IGNITION UNIT adds convenience to the Schöniger Oxygen Method. The Method is useful for converting organic carbon, halides including fluorides, sulphur, phosphorus and various metals into a soluble inorganic state in preparation for final determination.

WRITE FOR FREE LITERATURE

F&M SCIENTIFIC CORP.
1202 ARNOLD AVE., N. C. C. AIR BASE
NEW CASTLE, DEL. PHONE EA 8-6606

WILD* M-20
with Camera II

Fitted with Camera II, this truly versatile microscope permits continuous binocular observation of the specimen, even during exposure. The phototube deflects 25% of the light to the binocular tube, with the remainder going to the Camera. Rapid, accurate focusing is achieved with a special format indicating eyepiece in the binocular tube.

In research and scientific exploration, the M-20 is easily capable of handling any problem which may arise in optical microscopy.

Write for interesting information about the Wild M-20 and its complete range of attachments.

*The FIRST name in Surveying Instruments, Photogrammetric Equipment and Microscopes.

WILD HEERBRUGG *Full Factory Services* INSTRUMENTS, INC.

Main at Covert Street ● Port Washington, New York
PORt Washington 7-4843

In Canada
Wild of Canada Ltd., 157 Maclaren St., Ottawa, Ontario

Letters

The Drug Industry

Because so much of a superficial nature has been written as a consequence of the Senate's hearings on the drug industry, I have been particularly interested in the somewhat more thoughtful analyses prepared by *Science*. Your article last April [*Science* **131**, 1299 (1960)] showed a strong effort to maintain complete objectivity. But I have been puzzling for some time now over your report of 16 June, under the heading "The drug inquiry: a curious affair that has netted some solid results" [*Science* **131**, 1794 (1960)]. In brief, I find this report disappointing.

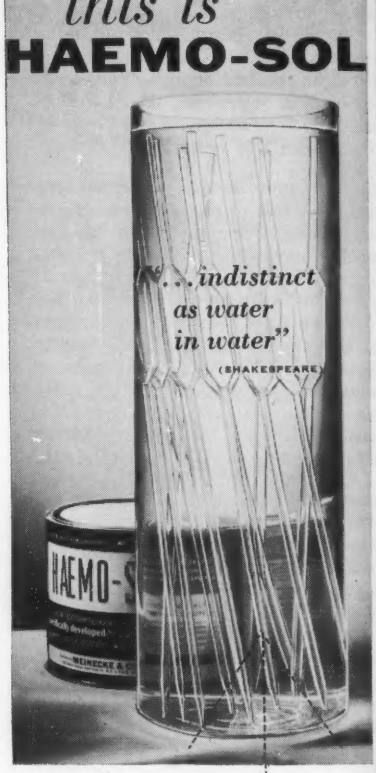
In the first place, you use the phrase "whatever complaints can be made about the style of the investigation." Covered by this brief, qualifying phrase is a perfectly outrageous demonstration of misleading, headline-hunting tactics. By implication, you take issue with such tactics.

However, you immediately go on to state that the "solid results" have "for the most part developed out of the publicity given the hearings, which the hearings won, in part, through the way in which they were conducted." Thus, you seem to endorse the use of questionable means to reach an end. And I cannot see that publicity is responsible for any results except unfair and misleading ones.

What do you call "solid results"? It seems clear to us that you are saying just this: after months of thin pickings, in which the drug industry could be pilloried only by misleading headlines, the Senate subcommittee came up with solid results when it turned its sights onto government agencies. Let me make it clear that if this is the real implication of what you are saying, I certainly do not espouse it, for I cannot condone the defamation of a fine agency such as the Food and Drug Administration on the basis of one or two incidents. If, on the other hand, you are saying that these "solid results" have come in regard to our industry, I can only ask, what are you referring to?

May I also refer to your comments on the "high-powered promotion race." While no one can reasonably deny the extent of this competitive manifestation. I think that most of your readers who are familiar with our industry will disagree with you that "there is pressure on every company to match the promotional effort of the least responsible companies." Likewise, I am confident that your readers will reject the generalization that "much of [this barrage of promotion] tends to be misleading." And, in the same sentence,

this is
HAEMO-SOL



you can *see*
what tests
prove...
...it's *always*

- **Totally Soluble**
- **Completely Active**
- **100% FREE Rinsing**

Yes, these pipettes will emerge C-P clean, free draining, sparkling.

It's so easy . . . just soak, then rinse. Your pipettes are really clean . . . no etching . . . no fogging . . . no residue.

Your Haemo-Sol solution is active all week. The cost? As low as 7/100 of a cent for each pipette!

Save time, money, work . . . and pipettes.

Clean with Haemo-Sol for every cleaning purpose.

Write for FREE sample and literature TODAY.

MEINECKE & COMPANY, Inc.
225 Varick St., New York 14

MEINECKE & CO. INC. SINCE 1892

I scarcely think your readers will adopt the assumption that this promotion is misleading "since its purpose is to sell goods rather than to inform the doctor."

Admittedly, our perspective, as members of an industry operating in a business environment, is bound to be weighted in favor of our vigorous—and we think generally efficient—methods of promotion. But, for all its weaknesses, we believe our system brings prompt and thorough information to the physician and allows him the maximum opportunity, at greatest personal convenience, to be well informed on the range of medicines our industry has placed at his disposal.

Finally, you raise a fundamental question about the appropriateness of allowing the drug industry to function within the structure of the competitive enterprise system. One's immediate reaction to this is to ask, why then should food, water, shelter—the things that affect not merely health but sheer survival—be supplied under the stimulus of the profit system? Cannot business incentive serve health equally well? I submit that our industry has served the public interest as well as or better than any other I know of.

I recognize that the social, economic, and political issues involved cannot be dismissed casually, but I worry about a philosophy that seems to suggest that health be "quarantined" into the government domain.

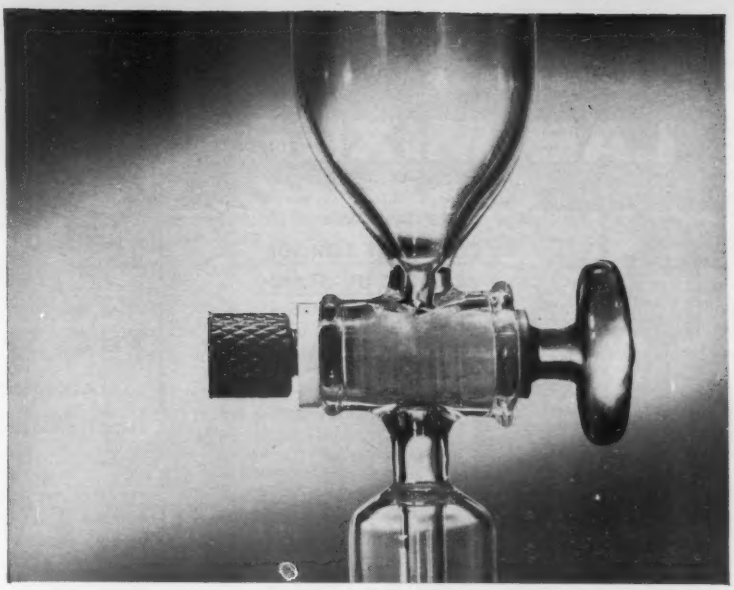
G. F. ROLL

Smith Kline and French Laboratories, Philadelphia, Pennsylvania

The "solid results" referred to were the indications that the climate of opinion brought about by the investigations had put the Food and Drug Administration in a position to initiate reforms which they had felt were advisable but which for years had been difficult to achieve because there had been little public interest in what the FDA wanted to do. One example is the recent tightening of regulations governing the information that must be included in drug promotion pieces. Another is the FDA proposal for a new factory inspection law.—ED.

Cannibalism

I was quite interested in Jay Boyd Best's recent article "Diurnal cycles and cannibalism in Planaria" (*1*) but question the use of *cannibalism* to describe the behavior observed. Webster's *New Collegiate Dictionary* defines a cannibal as "a human being that eats human flesh; hence, any animal that devours its own kind." Recent notes in ornithological journals report incidences



ace teflon® clad plug:

to "no grease"
ACE ADDS
"no jamming"

Ace has integrated the lubricity of Teflon with the low coefficient expansion of glass (which is 31 times smaller than the average coefficient of Teflon) and the result is the Ace Teflon Clad Plug, a better plug that lets you do this:

An Ace Teflon Clad Stopcock under tension can be cooled to 0°F, then placed directly in room temperature water without cracking the barrel. In most cases the plug can be turned with little extra effort.

By keeping the cold flow tendency of Teflon under control, Ace makes the most of it. Plugs tend to "wear in" to provide a perfect fit instead of "growing" out of round. Barrels are polished smooth—"grabbing" eliminated due to rough surfaces.

And you can use the Ace Teflon Clad Plug in vacuum systems where you wouldn't dare to use an all Teflon Plug. Greasing is necessary here, but the plug does not lose its lubrication as rapidly as plain glass parts. Action is smoother.

The single tension nut stays where put.

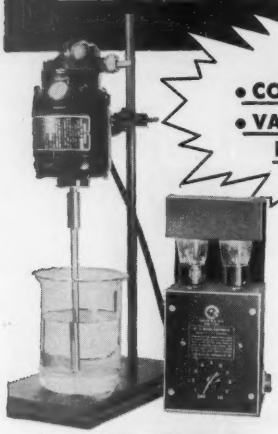
Write Dept. S for your copy of the current Ace Bulletin showing stopcocks, burettes, funnels available with the Ace Teflon Clad Plug.

® Reg. Trademark of E.I. du Pont de Nemours & Co., Inc.

ACE GLASS
INCORPORATED
Louisville, Ky., Vineland N. J. Springfield, Mass.

Circle No. 829 on Readers' Service Card

HELLER ELECTRONIC CONTROLLED LAB MIXER



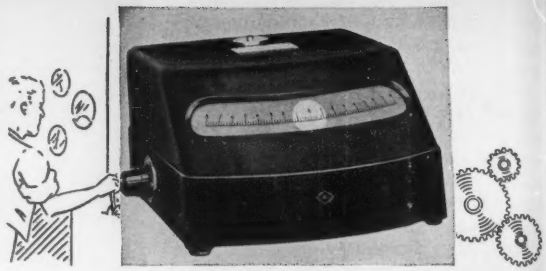
PROVIDES:
- **CONSTANT TORQUE**
- **VARIABLE DC SPEEDS FROM AC LINES**

• Thyratron tubes on the Heller GT-21 controller supply demanded current by converting power in stepless variation to the direct current motor. Assures constant torque as mixes become either viscous or fluid. Variable, reversible motor has direct and gear drive. Armature shaft speed, 0-5000 rpm. Gear shaft 18:1 ratio. Chuck, shafts, 3-step pulley included.

Complete with attachments F.O.B. Las Vegas **$90**

Order from your Laboratory Supply Dealer or write—

GERALD K. HELLER CO.
1819 Industrial Road Las Vegas, Nevada



THE SPOT GALVANOMETER

Laboratory Accuracy . . . Shop Ruggedness

The Cambridge Spot Galvanometer provides a complete outfit —galvanometer, lamp and scale—in one self-contained plastic case. It is robust, has a stable zero and does not require accurate levelling. The sharply defined spot can easily be read at a distance. The lamp may be operated on A.C. current or 6 volt battery. Sensitivities are 19, 30 or 170 mm. per microampere using coils of 20, 50 or 400 ohms respectively. Scale can be read to 0.2 mm.

OTHER GALVANOMETERS ARE AVAILABLE FOR A VARIETY OF APPLICATIONS IN INDUSTRY AND RESEARCH.
SEND FOR PRINTED LITERATURE.

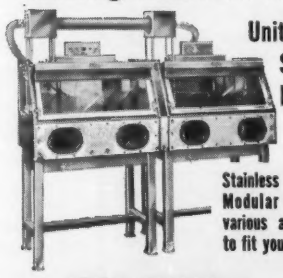
CAMBRIDGE INSTRUMENT CO., INC.
1618 Graybar Bldg., 420 Lex. Ave., N.Y. 17, N.Y.
PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

THE FINEST IN CAGES FOR LABORATORY DOGS & PRIMATES

THE ORIGINAL TIME-TESTED GLASS PLASTIC CAGE

molded seamless construction of rugged fiber glass reinforced plastics...minimum effort required to clean and disinfect... maximum animal comfort...extremely strong doors with fool proof catches...economical to purchase and maintain....For further information write:
Department KS
Kirschner
Vashon, Washington

22 types of Safety Enclosures for Handling Hazardous Substances



Unitized SAFETY ENCLOSURES

Stainless Steel, All Purpose: Modular adaptability with various adaptor accessories to fit your needs.

DRY RADIOACTIVE WASTE CONTAINER

All-welded stainless steel construction with stainless steel inner container.

Write for illustrated folder describing these and 20 other kinds of enclosures. S. Blickman, Inc., 6909 Gregory Avenue, Weehawken, New Jersey.

BLICKMAN SAFETY ENCLOSURES

Look for this symbol of quality Blickman-Built

of one bird killing and eating another of a different species (*2*). If these instances are accepted as cannibalism, should eating of song birds by avian predators such as hawks be termed cannibalism also? Some species, such as the blue jay (*Cyanocitta cristata*), which are not ordinarily predators will kill and eat young of other species (*3*). Stewart (*4*) describes as cannibalism the eating by one captive tufted titmouse (*Parus bicolor*) of another killed by a rat; yet this probably would not have occurred in free-living individuals.

Scavengers and carrion feeders will often eat dead members of their own species (I have observed this in gulls). Cannibalism is also said to occur in those colony-nesting gulls which kill and eat the young of neighboring nests (*5*), in storks and other species which eat their own young ("kronism") (*6*), and in owls in which siblings apparently eat one another (*7*). These latter types of "cannibalism" may function in population dynamics as "feedback mechanisms" to adjust the number of the year's offspring to the available food supply.

It seems to me that to call these (and other) kinds of behavior "cannibalism" directs attention away from analysis of the true adaptive significances of the observed phenomena. I suggest that the term *cannibalism* be restricted to improbable occurrences of adult animals feeding on other adults of the same species in the wild.

JACK P. HAILMAN
6037 Lake Terrace Circle,
Norfolk, Virginia

References and Notes

1. *Science* **131**, 1884 (1960).
2. See article and citations in J. K. Terres, *Auk* **73**, 289 (1956) and R. H. Backus, *ibid.* **71**, 471 (1954).
3. See article and citations in D. H. Lamore, *Wilson Bull.* **70**, 96 (1958).
4. *Auk* **72**, 83 (1955).
5. N. Tinbergen, *Herring Gull's World* (1953).
6. E. Schüz, *Die Vogelwarte* **19**, 1 (1957).
7. I. Collingwood, *Auk* **76**, 222 (1959); **77**, 256 (1960).

Jack Hailman is to be thanked for his contribution to linguistic precision. I stand corrected. On the other hand, the restricted definition proposed as a substitute for Webster's does not strike me as particularly useful. Of far richer import are Hailman's remarks hinting at what he believes to be the biological significance of cannibalistic (in Webster's sense) behavior. It is to this more beguiling problem that I would like to address the remainder of this letter.

The most interesting thing about cannibalism (in Webster's sense) is not that it occurs but rather why it does not occur more often than it does. By what cues, stimulus patterns, and behavioral restraint mechanisms is an animal that normally preys voraciously upon a wide spectrum of other species more or less inhibited from preying on its own kind? As a working hypothesis it would seem far more parsimonious to consider cannibalism to be an extension of an animal's normal spectrum of prey to include members of its own species than to consider it a specialized adaptive mechanism for adjusting population to food supply. Cannibalism could be expected, in the former view, to ensue whenever the hunger "drive" overrode the psychological mechanisms normally prohibiting predatory behavior directed against the animal's own species. That it may also function as a feedback mechanism in population dynamics, as suggested by Hailman, seems more or less incidental. Let us for convenience refer to Hailman's view as *A* and to the view which I choose to espouse as *B*.

Some patterns of attack specificity were observed among the planarians described in my report in *Science*. The immature *Dugesia tigrina* used in the experiments were kept in colonies of approximately 30 per bowl during the time they were being fasted. It was found that feeding reduced the incidence of attack of *D. tigrina* upon *Cura foremani* to zero. If cannibalism (in Webster's sense) had been common

Now you can handle gas in a syringe without fear of leakage. The Hamilton Gas Tight Syringe uses a stainless steel plunger coated with Teflon*, and a Teflon* gasket tip. The result is a smooth, firm plunger movement, and *no leakage to three atmospheres.* The Gas Tight Syringe is ideal for gas chromatography. It is also useful for pipetting corrosive liquids, or liquids which normally cement the syringe plunger to the barrel. *Tetrafluoroethylene Polymer (DuPont)

- **Graduation of scale accurate to ±1%**
- **Calibrated in milliliters at 20°C**
- **Plungers interchangeable**
- **Teflon* coated plunger, with Teflon* gasket tip**
- **Patent Pending**
- **0.10, 0.25, 0.50, and 1.0 ml capacity models—$19.00**
- **2.5, 5, and 10 ml capacity models—$20.00**
- **Order direct**

Write today for catalog of Hamilton syringes

HAMILTON COMPANY, INC.
P.O. Box 307-K, Whittier, California
PRECISION MEASURING EQUIPMENT FOR CLINICAL AND CHEMICAL RESEARCH

among the *D. tigrina*, they would have been sated at the time of testing and attacks upon the *C. foremani* would not have been observed. Thus, the probability of predatory attack of immature *D. tigrina* upon *C. foremani* must be much greater than the probability of attack upon each other. Nor were *C. foremani* observed to attack each other. Yet both species will attack and eat a wide variety of other small organisms—for example, *Tubifex* worms, mosquito wrigglers, and brine shrimp—and large, sexually mature *D. tigrina* will attack and eat smaller immature *D. tigrina*. Thus, even among the planarians, which are about the most primitive animals possessing a real central nervous system, there is considerable specificity in regard to predatory behavior directed against close relations. The cues inhibiting or releasing such behavior in planarians are still largely unknown.

Hypotheses *A* and *B* imply different sets of consequences, and these consequences could be used to distinguish which of the hypotheses is valid. To decide between them one might ask the following questions.

1) Within the set of animals having the physical capacity to kill and eat a member of their own species, is the incidence of cannibalism in a species positively related to the diversity of other species preyed upon by the members of the species in question? Hypothesis *A* would imply no such relation; *B* would. Consider Hailman's own citation of the fact that owl siblings kill and eat one another. Apparently siblings of less voracious predators do not. Why? As a teleological mechanism to adjust population to food supply, cannibalism should be equally useful for all species.

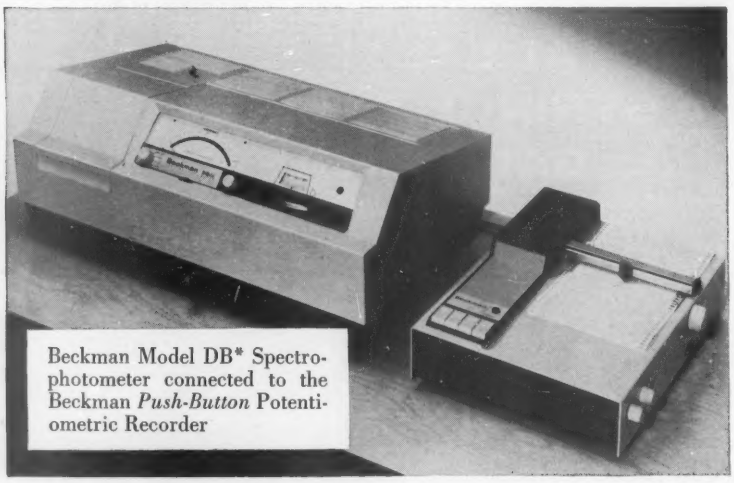
2) Is cannibalism as frequent among predators and omnivores that hunt and travel in packs as it is among those that are solitary hunters when the breadth of prey spectrum between the two types is comparable? I do not believe hypothesis *A* would predict any essential difference. Hypothesis *B* would predict a higher probability of cannibalism among the solitary hunters when they are placed together, because group living would favor the evolutionary selection of more powerful inhibitory mechanisms against cannibalism.

3) Among those species which are physically incapable of eating other members of their own species but which do possess the capacity to kill other members of their own species, does one observe an enhanced rate of killing of members of their own species in the absence of an adequate food supply? According to *A* one should, since the advantages of such an action as a population regulator are as effective as cannibalism; *B* would predict that one would not.

JAY B. BEST
Department of Neurophysiology, Walter Reed Army Medical Center, Washington, D.C.

Systematic Collections

Before the regulation on deposition of types proposed by the conferences on systematic collections [A. B. Grobman, *Science* **131**, 938 (1960)] is put into effect, "stable institutions" should be required to obtain from some properly qualified and independent authority a statement certifying just which kinds of organisms now are adequately curated and will be so curated in the future. Duplicating curatorial concentration on certain favored groups is so great as to warrant more than a suspicion that staffs of all such stable institutions in North America, even if combined, would not be in a position to look after specimens of every sort of extant organism. Institutions desiring certification also should be required to prove that they know how to retain specimens in a condition to function with some degree of usefulness as types, or else that they are en-



SPANS VISIBLE and ULTRAVIOLET RANGE!

At last . . . a *budget-priced* spectrophotometer that covers both the visible and the ultraviolet range—from 220 to 770 mμ! It's versatile, easy to use, and features programmed or manual slit systems for optimum resolution. Stray light is less than 0.5% at 220 mμ. Photometric repeatability is ±0.01 absorbance units at 0.400 absorbance. This instrument is ideal for accurate qualitative and quantitative analyses, medical and clinical studies, quality control and research.

Pictured also is the new versatile Beckman Potentiometric Recorder (range 10-100 mv) which adapts the DB for true %T recordings, differential analyses, and reaction-rate studies. It also may be used with other types of laboratory instruments.

Ask for bulletins 779 (DB) and 774 (recorder).

S-3975-5X Beckman 1401 DB Spectrophotometer, range 220 to 770 mμ. $1,865.00
S-3975X Beckman 1400 DB Spectrophotometer, range 325-770 mμ. $1,700.00
R-3200X Beckman Potentiometric Recorder, $475.00

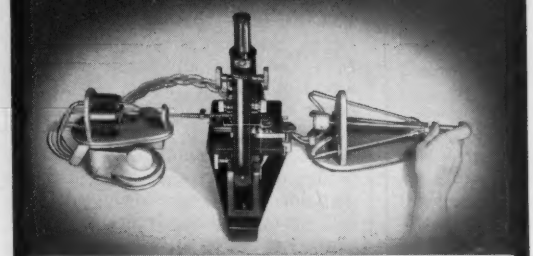
* Trademark, Beckman Instruments, Inc.

SCIENTIFIC GLASS APPARATUS CO. INC.
BLOOMFIELD, NEW JERSEY

LABORATORY...
♦ APPARATUS
♦ INSTRUMENTS
♦ CHEMICALS
♦ GLASSWARE

Branch Sales Offices: Albany 5, N. Y. • Boston 16, Mass. • Elk Grove Village, Ill. • Philadelphia 43, Pa. • Silver Spring, Md.
Branch Warehouse: Elk Grove Village, Ill.

MICROMANIPULATOR "CAILLOUX"



Unmatched flexibility of movements in all directions in space are achieved by natural hand movements under magnifications of 100 X to 2000 X without adjustment. The "Cailloux" advanced design combines maximum speed, precise response and stability with unusual ease of operation. Back-lash, parasitic vibrations and lag are eliminated. Prolonged manipulations can be conducted without fatigue. Includes many additional exclusive features.

LOW IN PRICE

Write for Additional Information

C. H. STOELTING COMPANY

Micro-Forge, Analytical Balances, Stereotaxic Instruments, Kymographs, Polygraphs, Strip Chart Recorders, Microscopes.

424 NORTH HOMAN AVE., CHICAGO 24, ILL.

DIFCO

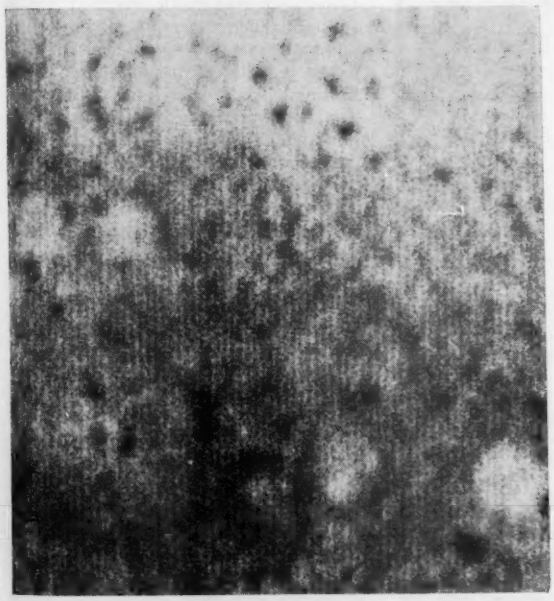
Dehydrated Culture Media DIFCO

The utmost in efficiency and economy in the bacteriological laboratory is realized through use of Dehydrated Culture Media, Difco.

Convenience—any medium can be instantly prepared.
Stability—media can be kept without deterioration.
Availability—each medium is instantly available.
Completeness—no additional ingredients are required.
Uniformity—successive lots are identical.
Comparability—dependable, comparative studies are possible in widely separated laboratories over long periods of time when standardized Difco Products are employed.

Specify "DIFCO"

DIFCO LABORATORIES
DETROIT 1, MICHIGAN



Shown is a microphotograph of Potassium Chloro Platinite, taken with an Hitachi HU-11 Electron Microscope, 1,750,000 photographic magnification, and with a resolution of 6.99 Angstrom Units!

EXPLORING FUNDAMENTALS . . . with the HITACHI HU-11

Hitachi's guaranteed 8-10 Angstrom Unit resolution allows you to probe the very basic structure of matter—making full use of the HU-11's 250,000x direct magnification.

The basic Hitachi HU-11, without accessories, serves as a highly efficient electron diffraction apparatus for use with opaque or transparent specimens. With such accessories as a low temperature stage, a high temperature stage, a reflection microscopy attachment and a X-Ray shadow camera, the Hitachi HU-11 allows investigations into every field of research.

ERB & GRAY SCIENTIFIC, Inc.

Exclusive Hitachi Distributors for the U.S.

854 S. Figueroa St., Los Angeles 17, Calif.
501 5th Ave., New York 17, N. Y.

SEPARATION

The Long Life Sieve is designed to allow the operator to replace the screen upon failure. The savings in cost of testing is realized when the cost of the replacement of the screen alone is compared with the cost of the replacement of the sieve screen unit as now practised. The frame of the sieve is constructed of chrome plated brass.

Vac-Pres Filters are bacteriological filters which may be used for vacuum or pressure filtration. These filters are available in 10 ml, 50 ml and 250 ml capacities. Other sizes upon request. The Vac-Pres Filters manufactured of brass with the interior silver plated and the exterior chrome plated. Stainless steel also available.

The CSI High Speed Angle Centrifuge gives the laboratory worker a reliable and modern high speed centrifuge with maximum safety and flexibility by its unit design and interchangeable standard rotors. Speed 14,000 rpm plus. (Pat No. 2,699,289)

BROCHURE AND PRICE UPON REQUEST

CUSTOM SCIENTIFIC INSTRUMENTS, Inc.

541 DEVON STREET KEARNY, N. J.

AN EDUCATION IN
LARGE FORMAT
PHOTOGRAPHY...

NEW
120 PAGE Linhof
PRODUCTS HANDBOOK

Over 400 illustrations, lens diagrams, and exploded views of the most exciting NEW line in Linhof history! Cameras, tripods, and accessories for photomicrography and macrophotography. Informative articles on the advantages, principles, and problems of large format photography... for the professional or advanced amateur.

only 50¢

See your Linhof Dealer ... or send coupon to:

KLING PHOTO CORPORATION
257-T Fourth Ave., New York 10, N. Y.

Here's 50¢ for my copy of the LINHOF PRODUCTS HANDBOOK.

name.....

address.....

city.....state.....

AT LAST! A REALLY CONVENIENT
AUTOMATIC
SYRINGE
ATTACHMENT

Repeats Preset Volume

- Assembles instantly
- Setting locks in place
- Available to fit standard syringes in ¼ - ½ - 1 - 2 - 5 and 10 cc. sizes

EASY TO HANDLE

Fine-thread adjusting screw permits accurate setting to any volume ... comes apart or reassembles with a slight twist without changing the setting.

Any syringe becomes an AUTOMATIC PIPETTE with this simple new attachment.

Ask your laboratory supply dealer, or write directly to:

Scientific Industries, Inc.
Dept. S-923, 15 PARK STREET
SPRINGFIELD 3, MASSACHUSETTS

gaged in research to such an end. Types of one economically important but neglected group, common almost everywhere in the world, usually are in the same sort of pickle (literally and figuratively) as they were a century ago, but if they are not, then they are in a still less satisfactory condition. All such types are slowly deteriorating. No effort is being made, so far as I know, in any stable institution anywhere in the world, to discover better techniques for preserving these animals.

The certifying authority also should be required to satisfy itself that the museum rules regarding types really will promote the advance of knowledge. One of several instances that can be cited is as follows. Species *x* was erected in 1871 on the basis of a single specimen, of which only the external characteristics were described, and those all too briefly. The authority on the group examined the type in 1888 but could add no information of importance, for he was not permitted to make a dissection. The species can belong to any one of six genera distinguishable from each other only by their internal anatomy. Each of some dozen monographs has had to waste space in vain repetition of the little that was known 70 years ago about this species *incertae sedis*.

G. E. GATES
University of Maine, Orono

Without reviewing the substance of Gates' remarks, with which I am in substantial agreement, I should like to point out that the conferences referred to did not discuss "regulations," "certification," or "certifying authorities." The conferences adopted some resolutions which I regard simply as recommendations to appropriate authorities by a group of informed specialists. No legalisms were implied.

ARNOLD B. GROBMAN
American Institute of Biological Sciences, University of Colorado, Boulder

Visual Effects

The photograph of the Arizona Meteor Crater on your cover for 22 July is excellent for the well-known demonstration of the effect of inverting the image. Held upside down, the crater appears to be a great mound. What makes this photograph especially good is the fact that it is taken from such a high point that the horizon does not show. Most astonishing effects may be obtained by holding the picture about 18 inches from the eyes and rotating it smoothly, at a rate of about 360° per minute, either clockwise or counter-

clockwise. At certain moments, when the picture is 90° or so from normal, the crater appears to be a great mass of rock completely detached from the ground. With somewhat more rapid rotation, and very steady fixation of the white area in the center of the crater, I tend to develop an amusing semblance of vertigo.

CLARKE W. CRANNELL
Department of Psychology,
Miami University, Oxford, Ohio

The High Cost of Reading

To read is to learn, and to know is to foresee and be strong. All this is easier if one has books of one's own, the more of them the better. But scholarly books are expensive, painfully so for those who need them most, the young and the unlearned.

New books are expensive because they are costly to produce, they sell in small numbers, and publishing houses must remain solvent. Financial aid in their distribution might make it possible to sell scholarly works at prices all those who wished them could afford. If more copies of a book would sell, unit production costs would decrease. Once such a program got started it might be that small sums of money would greatly increase the number of books made available to those who want them.

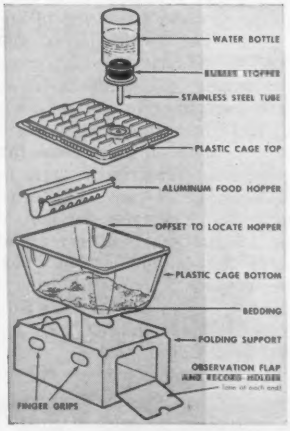
This new form of aid to the education of scholars and scientists seems to be a natural extension of the role of philanthropic foundations. Continuing a tradition of specialization, and in order to provide some measure of long-range effectiveness, a foundation interested in such a program might select a definite field of knowledge in which to help books reach their destined readers. Large foundations might choose large fields: virology, nutrition, cellular biology, linguistics. Less wealthy foundations could establish their identity by supporting more circumscribed fields: psychology of perception, history of biology, philosophy of science.

Financial aid in the publication of scholarly books is not a new idea, but heretofore such help has not been notably effective in making books cheaper. What is needed is some form of aid that would let a $6 book sell for $3, a $10 book for $4; perhaps no scholarly book should cost an interested individual more than $5 or $6. The selling price ought to be a test of serious interest and not a test of ability to pay. Anybody willing to spend $5 on a book on the chemistry of amino acids, or on comparative linguistics, deserves to have the book.

A system would have to be found which would preserve the tradition of

Now Available The New Unique S.I.U. Disposable Mouse Cage

Developed by the Microbiology and Design Departments of Southern Illinois University—



S.I.U. Disposable Mouse Cage Components
(Foreign and domestic Pats. Pend.)

Convenience — no cleaning, washing, sterilizing or maintenance — because, cages are disposable.

Safety — made of a new, tough, chemically inert plastic which is non-toxic. Designed to be escape proof.

Sanitary Handling — can be autoclaved (reducing size to 1/9 original) and then incinerated—or just incinerated. Eliminates unnecessary handling which promotes spread of infections to other animals.

Economy — initial cost per cage is no more than cost of cleaning, sterilizing, maintaining and storing other permanent cage types.

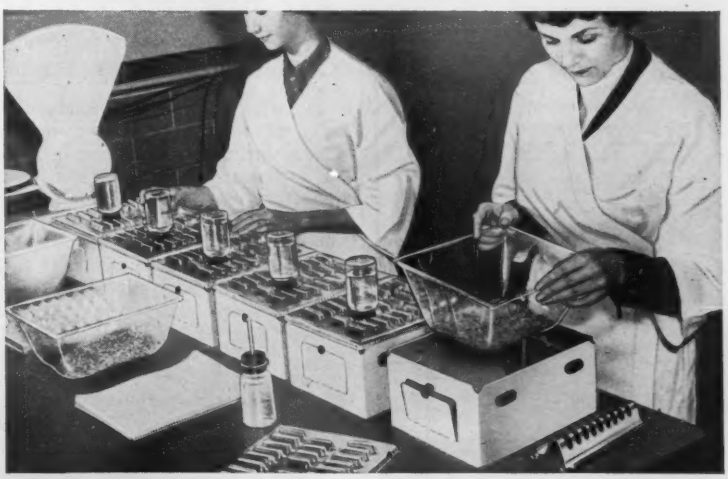
Storage Minimal — measuring 10″ long x 8″ wide x 4½″ deep; bottom area approximately 48 sq. in. Tops and bottoms designed to "nest," saving valuable storage space. 100 cages require but 4 cubic feet of storage.

The S. I. U. Disposable Cages have met all requirements for a low cost, convenient, escape proof and sanitary disposable cage as proved under actual field conditions.

To demonstrate the convenience and economy of the New, S. I. U. Disposable Mouse Cage, an Introductory Sample Test Package is available:

Aloe #1982 — Introductory Sample Test Package, S. I. U. Disposable Mouse Cage, consisting of 12 Bottoms, 6 Tops, 6 Supports, 6 Food Hoppers, 6 Water Bottles with Stoppers and Stainless Steel Water Tubes.....**Only $19.75**

Order Your Test Package Today; or, For Further Information and Demonstration Write:



aloe scientific / DIVISION OF BRUNSWICK CORPORATION
General Offices: 1831 Olive St. St. Louis 3, Mo.
FULLY STOCKED DIVISIONS COAST-TO-COAST

Your foremost supplier of complete Animal Care Equipment including MODULINE CAGES (all types—stainless, galvanized, etc.) • CAGE STANDS • FEEDERS & WATERING DEVICES • ANIMAL BALANCES • OPERATING EQUIPMENT • ANIMAL HOLDERS • CLIPPERS • I. D. EQUIPMENT • CLEANING/SANITIZING EQUIPMENT & CHEMICALS • (Custom requirements, too.)

DÆDALUS

Journal of the American Academy of Arts and Sciences

SPECIAL ISSUE
FALL 1960

ARMS CONTROL

"the necessary handbook for our times"

CONTRIBUTORS

- A. Doak Barnett
- Kenneth E. Boulding
- Robert R. Bowie
- Donald G. Brennan
- Harrison Brown
- Saville Davis
- Paul M. Doty
- Bernard T. Feld
- William T. R. Fox
- Erich Fromm
- William R. Frye
- Hubert H. Humphrey
- Herman Kahn
- Henry A. Kissinger
- Arthur Larson
- Ithiel de Sola Pool
- Thomas C. Schelling
- Louis B. Sohn
- Edward Teller
- Jerome B. Wiesner
- Christopher Wright

". . . the first really complete effort by experts in many fields to throw some new light on this vital issue."

—Ian Menzies
Boston Globe

"Nothing over here can compare with the American Academy of Arts and Sciences, nor with its excellent periodical *DAEDALUS*." —London *Observer*

DAEDALUS

Publication Office,
356 Washington St.,
Middletown, Ct.

☐ Please enter my subscription to the quarterly *DAEDALUS* as follows:
—1 yr. $5.50 —2 yrs. $10 —3 yrs. $14

☐ Please send only the issue "Arms Control" @ $2.00

—Payment herewith —Bill me

NAME _____

ADDRESS _____

_____

R10

free enterprise in the production and selling of books; our scientific publishers and booksellers are doing a fine job, and no one would want them disturbed. In fact, the type of program suggested here would strengthen the industry and the trade. The system should enable an individual to get the books he wants without much ado; there should be no test of the "need to have" or "need to know." To a layman in these matters, for booksellers simply to bill a given foundation for part of the price of each book sold from among those it supports would seem an acceptable solution; experts probably could think out something better, even if less simple. Public libraries, universities, and business firms would continue to pay the full price of supported books. The distribution of journals could be similarly helped; some of them, especially the ones in newer fields, are frightfully expensive. There is precedent for a journal's selling for less to individual subscribers than to organizations: subscription rates for the *Philosophical Review* of Cornell University are $3 per year for individuals and $6 per year for institutions. Regrettably this example is not widely followed.

STEVEN E. ROSS
2210 Jackson Street,
San Francisco, California

Science Teaching

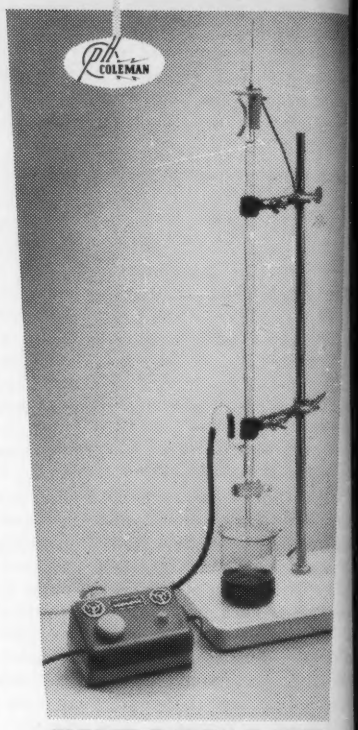
The report by Howard E. Gruber, "Science teachers and the scientific attitude" [*Science* **132**, 467 (19 Aug. 1960)], focuses attention on a critical problem in the preparation of science teachers.

In what ways can teachers be equipped to change the pattern of science instruction from one involving the mere cataloging of isolated scientific facts to one which reveals how scientists make use of the power of the human mind to perceive, think about, and eventually integrate seemingly unrelated arrays of impressions into broad conceptual schemes?

With the rate of growth of knowledge constantly increasing, the teacher who tries to present a body of facts (biology, chemistry, physics) without evoking some degree of understanding and appreciation of unifying fundamentals is bound to lead his students into a morass of frustrating confusion.

Since teachers-to-be are influenced to a great extent by the ways in which they themselves are taught, instructors of science training courses should emphasize and illuminate the processes of science and give the future teachers as many firsthand experiences with them as possible.

COLEMAN



AUTOFILLER

The push-button burette filler *automatically fills burette to zero mark*

The Coleman Model 27 Autofiller eliminates two of the most irksome and time-consuming operations in titrating . . . refilling the burette and adjusting the volumetric zero. It increases accuracy too—by always refilling to exactly the same titrant level. The Autofiller works with any standard, side-fill burette.

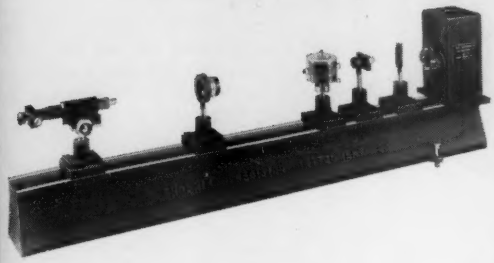
only $75.00
write for full details
BULLETIN SB-256

Order and simplification are the first steps toward mastery of any science

COLEMAN INSTRUMENTS, INC.
MAYWOOD, ILLINOIS

READER SERVICE CARD PAGES
837 AND 838 ARE MISSING.

Direct Measurement of Difference in Refractive Index



The New Brice-Phoenix Differential Refractometer uses a split cell to measure the difference in refractive index between a dilute solution and its solvent.

Limited sensitivity 3 X 10⁻⁶.

PHOENIX PRECISION INSTRUMENT COMPANY
3805 N. 5th St. Phila. 40, Pa.

UNSURPASSED
IN ADVANCED DESIGN AND OUTSTANDING PERFORMANCE

SI-RO-FLEX
ULTRAMICROTOME Model MK11

PROVIDES EXTREMELY UNIFORM SECTION THICKNESS IN LONG UNINTERRUPTED SEQUENCES

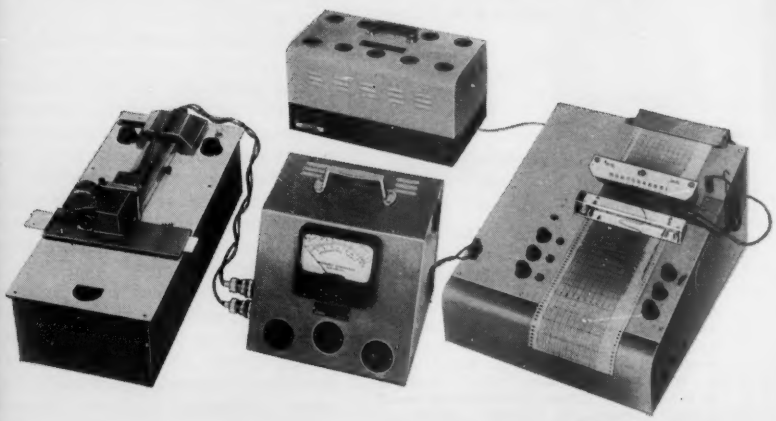
- Use of flexure strips which are not subject to wear or adjustment eliminates lateral excursion of specimen along knife edge.
- Provides extreme reproductibility of specimen path perpendicular to knife edge.
- Gives uniform sections in uninterrupted sequences even though knife edge is curved or marred.
- Has no bearings or slides that affect section uniformity-specimen advance by thermal expansion.
- Proved ability to cut sections of less than 140 A° in thickness.
- Supplied complete with hand and motor drives for 3 variable cutting speeds, adjustable fluorescent illumination and adjustable binocular microscope.

Write for complete specifications

SEE THE SI-RO-FLEX at the N.I.H. SHOW

SCHUCO SCIENTIFIC
DIV. OF SCHUELER & COMPANY / 75 CLIFF ST. NEW YORK 38
Mfgrs. of MEDI-SPRAYS & VOLUTEC

PHOTOVOLT DENSITOMETRIC EQUIPMENT for ELECTROPHORESIS and CHROMATOGRAPHY

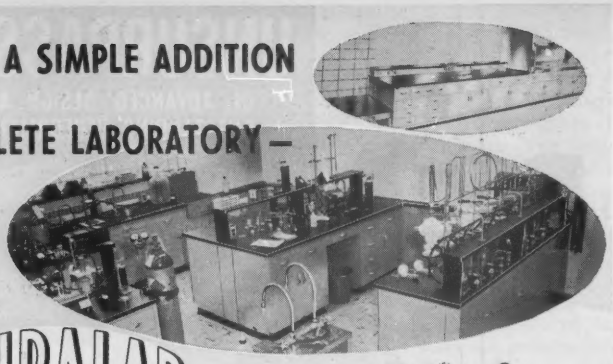


New building-block system permits adding of units as required, from manual and semi-automatic operation to fully-automatic recording and integrating

- For scanning of electrophoresis strips and readings on large sheets in chromatography
- For work in visible and ultraviolet ranges
- For evaluation by color-transmission, reflection or fluorescence
- For readings on filter paper, agar, starch and other gels

Write for Bulletin 800-S to:
PHOTOVOLT CORPORATION
95 Madison Avenue • New York 16, N. Y.

FROM A SIMPLE ADDITION to a COMPLETE LABORATORY—



THE DURALAB TEAM works for you!*

Send for our new complete Catalog D5

Sweets File No. 23L / DU

A.I.A. File No. 35-E

Working directly with architects, engineers and lab personnel, your particular requirements are integrated into plans for a finished job to serve you efficiently, economically and provide for the utmost in utility.

* 8 Engineering Services available to you at no additional cost.
- Preliminary Layouts
- Specifications
- Budgetary Estimates
- Firm Estimates
- Detailed Plans
- Controlled Manufacturing Procedures
- On-Time Deliveries
- Precision Installations

FACTORY TRAINED FIELD REPRESENTATIVES IN PRINCIPAL CITIES

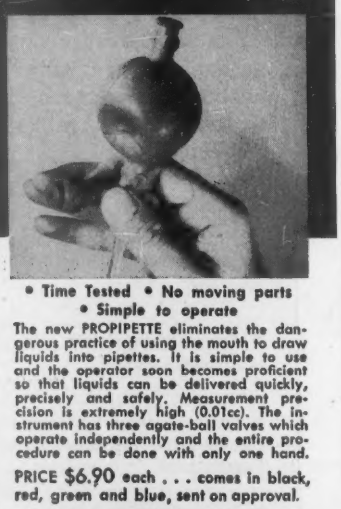
DURALAB EQUIPMENT CORP.

Manufacturers and Designers of Laboratory Furniture & Equipment

980 LINWOOD STREET, BROOKLYN, N. Y.

PROPIPETTE

Safety Pipette Filler holds liquids indefinitely



• Time Tested • No moving parts • Simple to operate

The new PROPIPETTE eliminates the dangerous practice of using the mouth to draw liquids into pipettes. It is simple to use and the operator soon becomes proficient so that liquids can be delivered quickly, precisely and safely. Measurement precision is extremely high (0.01cc). The instrument has three agate-ball valves which operate independently and the entire procedure can be done with only one hand.

PRICE $6.90 each . . . comes in black, red, green and blue, sent on approval.

all laboratory pipettes can be used with the PROPIPETTE—Safety Pipette Filler.

Write for additional information

INSTRUMENTATION ASSOCIATES

Distributors of Laboratory and Scientific Specialties

17 West 60th Street New York 23, N.Y.

RIGHT FROM STOCK

Model 25 Model 75 Model 150

VACUUM PUMPS

A new series of two stage, internal vane vacuum pumps offering...guaranteed ultimate vacuum of 0.1 micron . . . compact design . . . modern styling . . . three sizes and 31 types . . . Write today for Bulletin 610 . . . 12 pages of information . . . Immediate delivery on all pumps . . . Contact us for the name of your nearest stocking distributor.

BUILT BY PRECISION SCIENTIFIC CO.

3737 W. Cortland Street Chicago 47, Illinois

Local Offices in: Chicago • Cleveland • Houston New York • Philadelphia • San Francisco

Prospective teachers who, in this way, come to know the real flavor of the intellectual enterprise called science will be in a better position to transmit to their students the spirit of man's endless search to comprehend the world around him.

Teachers with such training will make sure that students do not get the impression that all the major discoveries already have been made; that the basic facts and principles of science are unchangeable; that there is nothing left for them to do but to learn about what others have done. Instead, these teachers will engender the feeling that there is always more to explore; that the road to discovery is wide open; that the horizons of science are unlimited.

Teachers with such training will know how to use curiosity to generate in their classrooms the kind of provocative stimuli that impel research scientists to pit their minds against the challenges of nature. They will know how to establish a free atmosphere in which individual initiative and ingenuity can flourish and in which each student is encouraged to express his own ideas no matter how far-fetched they may seem.

In *Walden*, Thoreau expressed the idea that "if a man does not keep pace with his companions perhaps it is because he hears a different drummer. Let him step to the music which he hears however measured or far away." What would be the impact on student interest and growth if this idea were to be adopted as one of the foundation stones of science instruction?

HARRY MILGROM

New York City Elementary Schools, and Elementary Science Project, Manufacturing Chemists' Association, New York

Pseudo Science and Censorship

The letter by H. C. Dudley on "Pseudo science and censorship" [*Science* **132**, 378 (12 Aug. 1960)] requires additional comment in rebuttal. Dudley makes a plea for fair-mindedness and questions the right of anyone to censor another's pronouncements as being "preposterous" or "crackpot."

Although examples may be quoted wherein reputable discoveries were denounced by contemporaries, examples of the reverse are truly legion. For an excellent compendium of wild ideas, crazy machines, crackpot inventions and theories, and general "magic black box" hoaxes, one may well read *Fads and Fallacies in the Name of Science*, by Martin Gardiner (Dover, New York, 1957).

Gardiner sets up a rather useful group of ground rules for separating

the honest effort in a new field from the work of the venial deluder or psychopathic crank. Thus, on pages 12 and 13 he outlines five excellent criteria which will trip up the crank.

Dudley's sense of fair play is admirable but does not, apparently, include the judicious selectivity required so desperately in our modern society. So often, today, individuals worry so about the rights of others and the problems of the minority that they allow the minority to subvert the ideals and steal the rights of the majority.

One is reminded of the tale of "The bear who let it alone" in James Thurber's *Fables for Our Times*. The moral of the tale is very relevant to conditions today. "You might as well fall flat on your face as lean too far over backwards."

F. W. MORTHLAND
4809 North 25th Road,
Arlington, Virginia

Starvation with and without Painful Hunger Pangs

Kelman (*1*), Wittenberg (*2*), and Ross (*3*) regarded starvation as too painful to justify its use in studies on animals such as Denenberg and Karas (*4*) made. The gnawing pangs of hunger are commonly considered to be the most disagreeable accompaniment of prolonged starvation, and hunger generally makes even a few days of fasting difficult. However, Kelman, Wittenberg, and Ross apparently did not take into consideration the fact that disagreeable hunger sensations usually decrease or disappear after the first few days in prolonged starvation without any food. Unfortunately, even widely accepted authorities like Cannon and Carlson did not agree about the manifestation of hunger during prolonged starvation, although both regarded the hunger experienced during a few days of starvation as consisting mainly of uncomfortable or gnawing sensations produced by periodic contractions of the fasting stomach (*5*, *6*). Cannon maintained that hunger disappeares after the first few days in prolonged starvation, while Carlson maintained that hunger persists. Cannon's view was based on the reports of others but not on any study made by him or his students. Carlson's view was based on a study made on himself and an assistant while they fasted about 5 days.

Eight years ago before I learned of Carlson's view by reading his monograph on hunger (*6*), I accepted the explanation of hunger or normal appetite advanced by Fletcher (*7*). Fletcher distinguished between a normal appetite and a false appetite but not between hunger and appetite. He considered normal hunger or appetite to be mainly of

Virtually no maintenance (supplies can't be damaged even by direct short circuit of output); long life; extremely fast response; transient-free, ripple-free output; and wide input frequency tolerance—these are just a few of the major features you get in Sorensen Q and QR Series transistorized supplies.

They're ideal for critical applications like powering computer circuits, strain-gauge bridges, or low-level instrument circuits.

Q Series Supplies: Offered in 15 models with nominal output voltages of 6, 12, 28 vdc (adjustable 2:1, approximately) and up to 220 watts power capacity. Models available for either ±0.25% or ±0.05% voltage regulation (combined line and load). Available in either cabinet or 19" rack-mounting styles (15 and 25 W models can also be provided for dual rack mounting on a single panel).

QR Series Supplies: Feature wide-range adjustable output voltage—zero to rated voltage, continuously, with COARSE and FINE front-panel controls. Two standard models: 0-36 vdc, 4 amps max., or 0-75 vdc, 2 amps max. Output is regulated to within ±(0.02% + 1 mv). Output voltmeter and ammeter. Units are available for cabinet or rack-panel (19" x 5¼") mounting.

Get complete specs on these outstanding power supplies. Ask your Sorensen representative or write: Sorensen & Company, Richards Ave., South Norwalk, Connecticut. O.3

Sorensen CONTROLLED POWER PRODUCTS
A SUBSIDIARY OF RAYTHEON COMPANY

New Sorensen catalog! Just off the press! 32-page catalog of more than 400 supplies plus valuable application data. Write for your copy today.

...the widest line lets you make the wisest choice

mental origin, false appetite to be often a manifestation of stomach craving. My observations largely seemed to support Fletcher's views. In 1913, I fasted 26 days, and my impression was that the reference of hunger to the stomach tended to disappear after about the fifth day. It therefore seemed that Carlson and his assistant simply did not fast long enough to note that the reference of hunger to gastric contractions decreases or disappears in prolonged starvation. Moreover, I believed that Carlson (and Cannon's student, Washburn) had merely found a better explanation of the desire to eat which Fletcher considered to be false appetite. A discussion with Carlson of my experience and findings led to his making a study of hunger on me at the University of Chicago, while I fasted 15 days in the summer of 1917. Actually, observations were made daily before, during, and after this fast and an additional 8-day fast, or during a total of 10 weeks in which I lived in Carlson's laboratory (*8*).

The periodic gastric or hunger contractions were found to be manifested throughout the 15-day fast, and the desire to eat was always increased more or less when the gastric contractions occurred. Carlson therefore felt that his previous view concerning the persistence of hunger during prolonged starvation had been supported. However, the increase in my desire to eat with the occurrence of gastric contractions was less after the sixth day of fasting. Carlson attributed this to a decrease in appetite, not to a decrease in hunger, because the records of the gastric contractions showed no change. He had previously explained in the same way a change in sensations noted after the second or third day of his 5-day fast. Neither Carlson nor Cannon ever made a clear distinction between hunger and appetite, and, as indicated in a letter published as an appendix to Carlson's report (*8*), I remained unconvinced that the sensations produced by the so-called hunger contractions represented the basic element in normal hunger.

Nevertheless, after my fasting in 1917 I seemed to find a closer relation between the need of food, the desire to eat, and the gastric hunger contractions than I had found before or during the fasting, and I realized that Carlson's and Cannon's explanation of hunger would have to be taken into consideration in any attempt to find a better explanation. I therefore gave my epigastric hunger sensations close attention, especially when I made changes in my dietary regimen. Thus, in 1924 I found that the periodic gastric contractions could be felt without any desire to eat whatever, under appropriate nutritional conditions. This was first noted when my stomach became empty early in the evening after I had deliberately eaten a large meal of easily digested and rapidly absorbed food early in the day. Subsequent observations made under less extreme conditions clearly indicated that the basic desire to eat (hunger) is more directly related to a central need of food than to emptiness of the stomach or the hunger contractions (*9*).

Before the foregoing finding was published, Carlson enabled me to begin a study with the use of facilities at his laboratory to determine whether a relation existed between the secretory activity of the fasting stomach and epigastric hunger sensations. Some of the gastric sensations seemed explainable by simple or spastic contractions of the muscles of the stomach, but others seemed to involve irritation or burning by acid. Observations on the secretory activity of the fasting stomach were usually made before and after observations were made on the motor activity with the aid of an inflated balloon in the stomach, in 1917. Variations in the gastric acidity were then noted, but no definite relation to the desire to eat or to the hunger contractions was noted. In 1925 I found that by making gastric aspirations every half hour, data were obtainable on both the secretory and the motor activity of the fasting stomach, and an interrelationship between the two functions was revealed (*10*). By alternately using the aspiration method and the balloon method of study, it became obvious that the gastric hunger contractions were simply the final gastric emptying contractions and that the number of contractions that could be felt was greatly increased by the presence of an inflated balloon in the stomach. There was no evidence that the fasting gastric functioning was significantly altered by the use of an aspiration tube—a conclusion reached after about 500 aspirations; over 3500 additional aspirations were then made. In a study made with Kleitman it was also found that a nonnutritive substitute for food tended to promote the development of hunger contractions instead of serving to prevent them while basal metabolism tests were being made (*11*).

At the same time that I began making observations on the secretory activity of the fasting stomach, in 1925, I began making variations in my protein intake in the hope of discovering, by chance, how protein is craved. My attempts to live on low protein or vegetarian diets between 1908 and 1918 always led to the development of a practically irresistible craving for meat. Raw beef was greatly appreciated under such circumstances and fully satisfied the craving, or more than sat-

NEW! FAST HEAT-UP TIME • FAST COOLING TIME

MELTING POINT APPARATUS

by Electrothermal

Fast heat-up and cooling cycles. (See chart below.) Allows for more determinations per day than with any other apparatus. Ensures reproducible results of known and constant accuracy. Clear view optical system allows changes occurring before, during and after melting to be observed in detail without distortion. No adjustment necessary to lenses or illumination source. A truly practical, economical and efficient apparatus.

HEAT-UP TIME		COOLING TIME	
Temperature	Minutes	Temperature	Minutes
to 100°C	1	from 360°C	
to 200°C	3	to 300°C	1, 5
to 300°C	6	to 200°C	4, 5
to 360°C	9	to 100°C	9
to 400°C	15	to 40°C	16

Cat. No.	Description	Quantity	Price
S78488	Electric Melting Point Apparatus tapped for 100-130 volts, 200 volts, 220 volts, 230 volts, 240 volts or 250 volts, complete with 'Aquadag' and one hundred Capillary Tubes. Supplied without Thermometer.		193.50
S78489	Thermometer, borosilicate glass 0°C. to 360°C.	One	18.80
S78490	Pack of Capillary Tubes, closed both end, 100 mm. x 1.5—2.0 mm.	1200	26.50
S78491	Bottle of 'Aquadag' colloidal graphite 2¾ oz.	One	2.40
S78492	Replacement Heating Element.	One	3.70

STANDARD SCIENTIFIC Supply Corp. 808 BROADWAY NEW YORK 3, N.Y.

LABORATORY APPARATUS REAGENTS AND CHEMICALS

Now Available from Sigma
PEPTIDES and INTERMEDIATES

N-ACETYL-D-ALANINE
N-ACETYL-DL-ALANINE
N-ACETYL-3,5-DINITRO-L-TYROSINE
N-ACETYL-3,5-DINITRO-L-TYROSINE ETHYL ESTER
N-ACETYL-D-ETHIONINE
N-ACETYL-DL-GLUTAMIC ACID
N-ACETYL-L-GLUTAMIC ACID
N-ACETYL GLYCINE
N-ACETYL-D-(allo)ISOLEUCINE
N-ACETYL-D-LEUCINE
N-ACETYL-DL-LEUCINE
N-ACETYL-DL-METAFLUOR-PHENYLALANINE
N-ACETYL-D-METHIONINE
N-ACETYL-DL-METHIONINE
N-ACETYL-DL-5-METHYL TRYPTOPHANE
N-ACETYL-L-NORVALINE
N-ACETYL-D-PHENYLALANINE
N-ACETYL-L-PHENYLALANINE
N-ACETYL-D-PHENYLALANINE-p-NITROPHENYL ESTER
N-ACETYL-L-PHENYLALANINE-p-NITROPHENYL ESTER
N-ACETYL-DL-PROLINE
N-ACETYL-DL-TRYPTOPHANE
N-ACETYL-L-TRYPTOPHANE
N-ACETYL-L-TYROSINE AMIDE
N-ACETYL-D-VALINE
N-ACETYL-DL-VALINE
DL-ALANYL-β-NAPHTHYLAMIDE
ALLYL GLYCINE
p-AMINO BENZOYL-L-GLUTAMIC ACID
DL-7-AZATRYPTOPHANE
N-BENZOYL-L-ALANINE
δ-N-BENZOYL AMINO VALERIC ACID
BENZOYL-L-ARGININE
α-BENZOYL-L-ARGININE AMIDE HCl
N-BENZOYL-DL-VALINE
S-BENZYL-L-CYSTEINE
imBENZYL-L-HISTIDINE
o-BENZYL-DL-SERINE
o-BENZYL-L-TYROSINE
N-CBZ-L-ALANINE
N-CBZ-L-ALANYL-L-VALINE, METHYL ESTER
N-CBZ-L-ARGININE HBr
N-CBZ-L-ASPARAGINE
N-CBZ-L-ASPARTIC ACID
N-CBZ-S-BENZYL-L-CYSTEINE
N-CBZ-o-BENZYL-L-TYROSINE
N-CBZ-GLYCINE
N-CBZ-L-GLYCINE ETHYL ESTER
N-CBZ-GYCINE-p-NITROPHENYL ESTER
N-CBZ-GLYCYL-L-PHENYLALANINE
CBZ-GLYCYL-L-PROLYL-L-LEUCYL-GLYCYL-L-PROLINE
N-CBZ-L-ISOLEUCINE
N-CBZ-L-LEUCINE
N-CBZ-L-LEUCINE-p-NITROPHENYL ESTER
N-CBZ-L-LEUCYL GLYCINE
N-CBZ-L-LEUCYL-β-NAPHTHYLAMIDE
N-CBZ-L-METHIONINE
N-CBZ-L-METHIONYL GLYCINE ETHYL ESTER
N-CBZ-D-PHENYLALANINE
N-CBZ-D-PHENYLALANINE-p-NITROPHENYL ESTER
N-CBZ-L-PROLINE
N-CBZ-L-PROLINE-p-NITROPHENYL ESTER
CBZ-L-PROLYL-L-LEUCYL-GLYCINE
N-CBZ-DL-SERINE
N-CBZ-L-SERINE
N-CBZ-L-TRYPTOPHAN
N-CBZ-L-TRYPTOPHAN-p-NITROPHENYL ESTER
N-CBZ-L-VALINE
N-CBZ-L-VALINE-L-LEUCINE
N-CBZ-L-VALYL GLYCYL GLYCINE BENZYL ESTER
N-CBZ-L-VALYL-L-LEUCINE METHYL ESTER
N-CBZ-L-VALYL-L-PHENYLALANINE
N-CBZ-L-VALYL-L-TYROSINE, METHYL ESTER
N-CHLOROACETYL GLYCINE
N-CHLOROACETYL-L-ISOLEUCINE
DL-CHLOROACETYL NORVALINE
N-CHLOROACETYL-DL-PHENYLALANINE
N-CHLOROACETYL-L-PHENYLALANINE
N-CHLOROACETYL-DL-TRYPTOPHANE
N-CHLOROACETYL-L-TRYPTOPHANE
N-CHLOROACETYL-D-VALINE
N-CHLOROACETYL-DL-VALINE
N-CHLOROACETYL-L-VALINE
CYSTEINE METHYL ESTER HCl
N-DIACETYL-L-TYROSINE
DIBENZYL-L-HISTIDINE

See additional listing next month

Many others are in preparation.

CALL US COLLECT AT ANY TIME, JUST TO GET ACQUAINTED

Day, Station to Station,
PRospect 1-5750

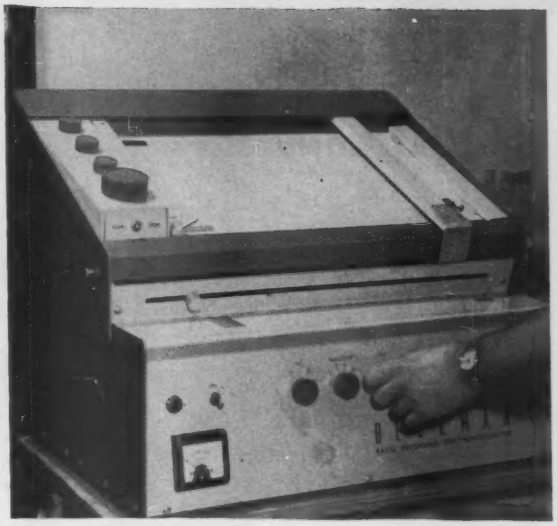
Night, Person to Person,
Dan Broida, WYdown 3-6418

The Research Laboratories of

SIGMA
CHEMICAL COMPANY

3500 DEKALB ST., ST. LOUIS 18, MO., U. S. A.

NYLAB presents...



THE BECKMAN DK SPECTROPHOTOMETER .... used in more applications than all other recording spectrophotometers combined.

The DK Spectrophotometer is automatic and simple to use . . . has excellent coverage of ultraviolet, visible and near infrared spectral regions . . . with wavelength range of 185 to 3500mu plus optional optics for probing the far-ultraviolet to 175mu . . . makes analyses faster, turns out more analyses using same number of laboratory personnel . . . lowest priced recording spectrophotometer available.

You can arrange for a demonstration . . . more technical information . . . or for immediate delivery. Write or call today.

NYLAB
New York Laboratory Supply Co., Inc.
76-78 VARICK STREET NEW YORK 13, N. Y.

Now Available

CARBOXYPEPTIDASE

B

Preparation based upon the method of Folk et al[1] and is of comparable activity using hippuryl-L-arginine as substrate[2].

1. Folk, J. E.; Piez, K A.; Carroll, W. R. and Gladner, J. A.: Carboxypeptidase B. Journal of Biological Chemistry 235 #8, 2272 (1960).

2. Folk, J. E. and Gladner, J. A.: Carboxypeptidase B: I. Purification of the Zymogen and Specificity of the Enzyme. Journal of Biological Chemistry 231 #1, 379 (1958).

worthington

For information, write or telephone:

worthington biochemical corporation

FREEHOLD I, NEW JERSEY

HOPKINS 2-3838

isfied it in a few days. This craving seemed to be an instinctive call for more or better protein, but no explanation of the manner in which the craving was manifested and dispelled suggested itself. However, it soon became evident in 1925 that the gastric acidity of fasting increased with protein restriction and decreased with restoration of protein (*12*), and when protein restriction was carried to an extreme, the easily recognized protein craving or protein hunger manifested itself and soon became excruciating epigastric hunger pangs (*13*). These were not directly related to the gastric hunger contractions but took my breath away and were first objectively recorded by disturbing my breathing when a basal metabolism test was being made. The painful sensations seemed to be produced by irritation of the duodenum or parapyloric region by highly acid gastric contents when they were being discharged from the stomach. The duodenum or parapyloric region probably was also made hypersensitive by the protein restriction or protein starvation. At the same time the gastric secretion was evidently kept at a high level through consumption of plenty of low-protein food.

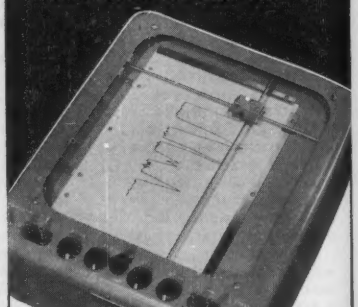
As an alternative to simple protein restriction, I also tried fasting in 1925 to produce protein starvation. My original intention was to fast only 1 or 2 days intermittently, but I took advantage of an opportunity to serve as a subject in a study of the effect and after-effect of prolonged fasting on mental performance (*14*) and thus undertook my longest fasts, of 33 and 41 days, respectively. Prolonged fasting involves more or less dehydration, partly because of carbohydrate starvation, and the gastric secretion was found to be depressed more or less after the first few days. No epigastric protein hunger pangs were experienced during the prolonged fasts, but displays of fat meat seemed almost irresistible toward the end of the fasts. After the fasts, the gastric acidity became higher than before fasting, and I experienced more or less protein hunger. It also was difficult to restrict the food intake again until after I had become fatter than before fasting. During these long fasts, tests were made to determine the effect of drinking more water than I needed (500 ml). The result was that the gastric acidity became increased after the water left the stomach, and the gastric hunger sensations were also increased (*15*).

I never tried fasting without drinking water, but Cannon (*16*) cited the experience of Viterbi, a political prisoner, who kept a diary while he abstained from drinking as well as eating until he died on the 18th day. Apparently, hunger disappeared sooner and more completely after the first two days than would have

HR-92 X-Y

X-Y RECORDER

Unconditionally Guaranteed For One Year



LOW $595.00 COST

- Flat bed — Full Chart visibility
- Unitized Construction
- Critically damped response
- Clip-on pen — Interchangeable for multicolor traces
- Standard 8½ x 11 paper

RUGGED "All Purpose" X-Y RECORDER

The HR-92 is a null-seeking servo-type plotter designed to draw curves in Cartesian coordinates on regular 8½ x 11 graph paper. Control panel has zero set and continuously-variable attenuator for each axis. Separate standby and power switches are provided. Two axes are electrically and mechanically independent.

- Amplifiers easily removed if servicing ever becomes necessary. Electrical connections all contained in two plugs for each amplifier.
- Each amplifier channel (including transformer power supply) independent of rest of system.

WRITE FOR:
New X-Y Recorder Circular #792-4 showing complete specifications and photographs.

houston instrument corporation

Box 22234 · Houston 27, Texas
MO 7-7405

been the case had he drunk water, because of the dehydration involved, and death was hastened.

In any case, it seems of interest that the lack of an adequate amount of an essential food like protein is likely to be accompanied by more pain than starvation without any food or water.

FREDERICK HOELZEL
6659 South Stewart Avenue, Chicago, Illinois

References

1. R. B. Kelman, *Science* **131**, 263 (1960).
2. A. Wittenberg, *ibid.* **131**, 1562 (1960).
3. S. E. Ross, *ibid.* **131**, 1563 (1960).
4. V. H. Denenberg and G. G. Karas, *ibid.* **130**, 629 (1959).
5. W. B. Cannon, *Digestion and Health* (Norton, New York, 1936).
6. A. J. Carlson, *The Control of Hunger in Health and Disease* (Univ. of Chicago Press, Chicago, 1916).
7. H. Fletcher, *The A. B.–Z. of our own Nutrition* (Stokes, New York, 1903).
8. A. J. Carlson, *Am. J. Physiol.* **45**, 120 (1918).
9. F. Hoelzel, *ibid.* **82**, 665 (1927).
10. ———, *ibid.* **73**, 463 (1925).
11. N. Kleitman, *ibid.* **77**, 233 (1926).
12. F. Hoelzel, *ibid.* **77**, 166 (1926).
13. ——— and N. Kleitman, *A.M.A. Arch. Internal Med.* **39**, 710 (1927).
14. J. A. Glaze, *Am. J. Psychol.* **40**, 236 (1928).
15. F. Hoelzel, *Am. J. Digest. Diseases* **11**, 71, 101 (1944).
16. W. B. Cannon, *Bodily Changes in Fear, Hunger, Pain and Rage* (Appleton, New York, 1915).

Training of College Teachers

I note in your editorial "Real professionalism" [*Science* **132**, 439 (19 Aug. 1960)] that the National Education Association is now attempting to impose state licensure and a requirement "to study the theory and practice of education in the course of their professional education" on college and postgraduate educators.

I have long been disenchanted with the training too many of the school educators receive at the "teachers colleges," whose curriculum is so heavily laced with courses on how to teach but seems so weak in the subjects to be taught. Are we now to inflict the same "uniformity" (or is it mediocrity) on the collegiate instructors?

Perhaps I am too naive in my belief that the two essential characteristics of a good teacher are (i) enthusiasm and (ii) thorough knowledge of and interest in his subject.

JOHN HELWIG
Hospital of the University of Pennsylvania, Philadelphia

Brain Dysfunction

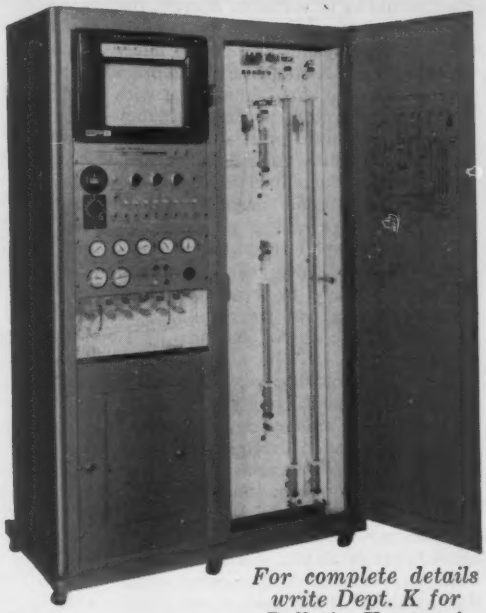
A report by Wells and Wolff [*Science* **131**, 1671 (1960)] offers a slim but adequate excuse for me to make some remarks which I have been saving up for some time.

The authors cite a fascinating experi-

NEW PHOENIX MODEL K-5000-A AMINO ACID ANALYZER

Now Available For Combined Analytical—Preparative Analysis With the

MODEL 5500 STREAM SPLITTING SYSTEM



P|P|I

PHOENIX PRECISION INSTRUMENT COMPANY

For complete details write Dept. K for Bulletin K 5000-A

3803-05 NORTH FIFTH ST., PHILADELPHIA 40, PENNSYLVANIA

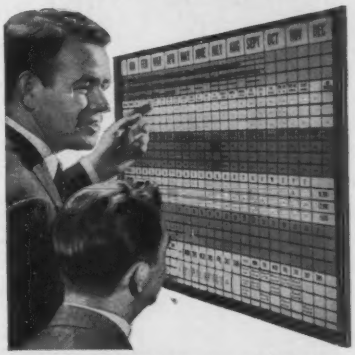
STEREO-MICROSCOPE

PROMPT DELIVERY
Long Working Distance
Superb Optics
Magnifications 6X-200X
Large Variety of Accessories
Old World Craftsmanship

ERIC SOBOTKA CO.

108 West 40th St.
New York, 18, N. Y.
Specialists in Imported Equipment

How To Get Things Done Better And Faster



BOARDMASTER VISUAL CONTROL

- ☆ Gives Graphic Picture—Saves Time, Saves Money, Prevents Errors
- ☆ Simple to operate—Type or Write on Cards, Snap in Grooves
- ☆ Ideal for Production, Traffic, Inventory, Scheduling, Sales, Etc.
- ☆ Made of Metal Compact and Attractive. Over 500,000 in Use

Full price $49.50 with cards

FREE 24-PAGE BOOKLET NO. BF-10 Without Obligation

Write for Your Copy Today

GRAPHIC SYSTEMS
Yanceyville, North Carolina

ment in conditioning of cerebral responses, finding significant differences between "normals" and persons evidencing severe anxiety. This observation in itself would be of sufficient interest, but the authors have gone on to use the data in a rather backhanded fashion to imply that the differences must be due to brain damage of some sort, hinting that with sufficiently sensitive techniques, they might "demonstrate other evidences of impairment" which are the real, actual, true cause of functional behavior disorders and not some magical kind of "neurosis" or "psychosis" as some people think. Perhaps I am unfair to Wells and Wolff, but I have heard essentially this view expressed by enough members of the working and teaching medical profession to convince me that it is widespread.

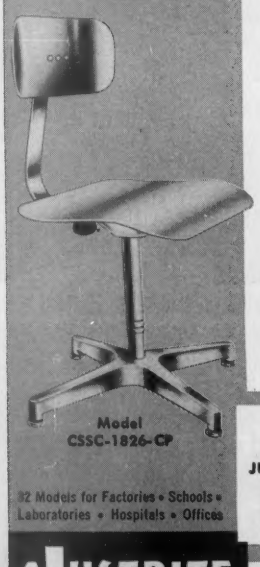
In support of this view that brain damage lies behind every psychological malfunction is an impressive array of clinical information demonstrating that psychological malfunctions can be and are caused by certain kinds of brain damage (although brain damage sometimes shows a disconcerting failure to affect behavior at all). There is no evidence at all to show that every functional disorder is the result of structural damage to the brain. The science least likely to resolve this implied problem is the science of electroencephalography.

The electroencephalograph measures the gross electrical activity of the brain, which results from the fields and currents generated in unknown patterns by an unknown set of neurons somewhere near the surface of the brain. The electroencephalograph can thus detect changes in activity of large assemblies of neurons, and because of this and because of the complexity of the signal, can differentiate between grossly different patterns of brain activity. In the same manner, a high-impedance probe inserted into the main frame of a computer could be used to detect (empirically) changes in the routing and number and time patterns of electrical signals; a patient observer might correlate these changes with certain gross malfunctions in the computer and use them for diagnosis, as the electroencephalogram is often used.

Suppose, however, that one day the computer technician attached his probes and recorded the patterns of signals and found some extreme changes which failed to resemble any of the "normal" traces. Should he decree an emergency operation? Perhaps, or perhaps not; he will have to find out first (i) whether there is a mistake in the program so that the computer has started dividing by zero; (ii) whether a new type of program is being used so that the patterns of activity are not typical of the usual sort of program; (iii) whether the machine has been told to do something it cannot do; and (iv) whether any of the other things which can have the observed effect without failure of any part of the machine (and there would be many of them) have happened. True, certain typical disorders are likely to have typical effects on the "electrohardwareogram," so that after one has observed the coincidence enough times he feels confident in making certain diagnoses, but it is entirely possible, if not probable, that merely by programming the machine *just so* one could simulate a tumor in a transistor or a lesion in a loop.

A medical student once protested to me, after listening to some of my propositions concerning a model for behavioral organization, "But you can't know anything about function without knowing structure!" In the brain, I suspect that the opposite is true: you can't know anything about structure (that is, organization) until you first know function (what the structure does). I suspect that the medical student sometimes uses machines of which he understands the function considerably better than the structure, and I know for fact that even some of the most sophisticated of com-

SPECIAL CHAIRS FOR WHITE ROOMS AND DUST FREE AREAS



- All Enclosed Mechanism
- No Oil or Grease
- All Chrome Plate Finish
- Easily Cleaned
- 12 Ga. All-Steel Seat; 14" x 15¾"— Waterfall Form. Sand Blast Surface. Adjusts 18" to 26".
- 12 Ga. Steel Backrest; 6" x 13¾"—with tempered steel backrest support. 6 inch horizontal adjustment. Backrest folds down to make easy cleaning.
- Cast Iron Base; 20-inch spread. 1⅛" steel glides.

Other White Room chairs with lacquered plywood seat and backrest.

FREE TRIAL Use an AJUSTRITE chair for 30 days without obligation. Prove to yourself the many advantages AJUSTRITE offers in comfort, utility and economy. Write today—we'll do the rest.

10 YEAR GUARANTEE

Model CSSC-1826-CP

32 Models for Factories • Schools • Laboratories • Hospitals • Offices

AJUSTRITE CHAIRS AND STOOLS

AJUSTO EQUIPMENT CO.
Bowling Green, Ohio

EXPOSED!

TO CROSS-INFECTIONS

HANDS — most active in distribution of INFECTION! For the management and handling of specimen containers requiring a label, use a "no-lick" TIME Tape or TIME Specimen Collection Label for service, a new advancement specified in the "Guide to Laboratory Safety".*

Every dressing, every collection of specimen, blood, sputum, etc. requires hand service. Eliminate contact by using the satin finish, vinyl coated TIME Tape or Label.

A qualified consultant will teach you the effective TIME procedure. It is your first step to a safer laboratory. Write today to Dept. RH.

* *In April 1960 issue of Lab World.*

TIME LABELS

PROFESSIONAL TAPE CO., INC.
333 BURLINGTON AVE. • RIVERSIDE, ILL.
Hickory 7-7800

puter users may well consider a study of flip-flops, diode storage times, and bit density on tape a waste of their time, leaving that to those who want to build, not use, computers. The best way to learn how computers work is certainly *not* to start by studying the metallurgy of copper wire, vacuum tube or transistor theory, and the quantum mechanics of conduction processes. One could know all that there is to know about these "fundamental" aspects of a computer and still be completely, or at least largely, ignorant of the various functions which a computer can carry out so usefully. One could know all there is to know about synaptic processes, cell metabolism, and the routing of impulses through the brain and still not be able to make heads or tails of what the blamed thing is *for*. Only through a thorough analysis of the things which people can do, and orderly construction of a model representing these functions and their interrelationship, can one understand "brain activity." Only then can one group the various structures he has found and has yet to find into meaningful assemblies which tell him anything, which bear any comprehensible relationships to each other. I stood by once and heard a neurosurgeon comment to a colleague, during a cleaning-up process where a brain tumor had been, "Look there—that's all good brain." This might be called the simplest concept of function; as long as there's enough good brain left to secrete behavior, you're OK.

I don't claim that psychologists or cyberneticists have yet published anything that is very helpful in helping us understand brain structure, but I will assert that no neurologist has ever published anything (limited sample admitted) that helps us understand why our neighbors' children are so inferior to ours.

Behavioral science and neurology are still a long way apart, and the attitude of many neurologists toward the psychological approach is no help in getting them together. The childlike faith that sufficiently fine measurement and sufficiently thorough chemical analysis will explain behavior may sustain one through periods when nothing seems to explain anything, but it *is* a faith, not a fact, and ought not be referred to as if it were proven and self-evident. The essence of science is measurement, and measurements yield numbers; the numbers remain numbers until some human being fits them into his concept of a system which performs certain functions; only then do the numbers mean anything at all. And if the human being had not started with some guess about function, he never would have made a meaningful measurement.

I argue, therefore, that not only is

National Appliance Co.
7634 S.W. Capitol Hy. • Portland 19, Ore.
Eastern Sales:
H. Reeve Angel & Co., Inc.
9 Bridewell Pl. • Clifton, N. J.

NATIONAL APPLIANCE

INCUBATION

. . . for *efficient, modern* study of bacteria, virus, tissue cultures by CO_2 technique.

National Appliance has designed six CO_2 incubators for use in hospitals, pathology clinics, veterinarian schools and laboratories, research laboratories, public health laboratories, as well as plant and animal sciences.

Incubators now manufactured by National represent the three methods of obtaining CO_2 atmospheres: batch displacement, vacuum and continuous flow. National's CO_2 incubators are designed for critical control of temperature, CO_2 tension and moisture content with flexibility of variations. They are designed for use as wet or dry chambers with a line of water-jacketed incubators providing for ultimate temperature control. There is a National CO_2 incubator ideally suited to your purpose.

FREE: *Send now for a free copy of Bulletin No. 6051, "Carbon Dioxide Incubation." In it you will find a complete description of applications, methods and advantages in the use of CO_2 incubation. In it, also, is catalogued National's complete line of CO_2 incubators and accessories, including price lists.*

NATIONAL APPLIANCE

Second Printing July 1960

AAAS Symposium Volume No. 52

EVOLUTION OF NERVOUS CONTROL FROM PRIMITIVE ORGANISMS TO MAN

Editor: Allan D. Bass

1959, 240 pp. $5.75, AAAS members' prepaid orders $5.00

From a review in the Psychiatric Quarterly, January 1960:

This book is another in the superb series of monographs put out by the American Association for the Advancement of Science. . . . The text is actually a very readable review of some of the major research going on in various phases of neuropsychiatry.

This book offers much more concrete and useful data than do a number of larger tomes dealing with the interdisciplinary approach to mental disease. It may be profitably read by anyone interested in the differing aspects of, or approaches to, the study of the nervous system and its activity.

British Agents: Bailey Bros. & Swinfen, Ltd. Hyde House, W. Central St. London, W.C.1

AAAS
1515 Massachusetts Avenue, NW
Washington 5, D.C.

RIDL . . . the COMPLETE LINE OF RADIATION INSTRUMENTS

Model 50-1 Spectrometer

- Scintillation Detectors
- Scalers — Amplifiers
- Count Rate Meters
- Spectrometers
- Pulse Generators
- Electronic Sweeps
- Gas-Flow Counters
- End-Window Counters
- Preamplifiers — All Types

. . . alpha, beta, gamma, x-ray and neutron detectors . . . along with 31 types of scalers and a full line of associated amplifiers and preamps . . . are available from RIDL. For general electronics laboratory use, RIDL also manufactures a precision pulse generator, count rate meters and a variety of high voltage supplies. All types of spectrometers are custom assembled from standard components. The RIDL line of radiation instruments is made complete by several single channel pulse height analyzers and two and four channel coincidence/anti-coincidence analyzers. For the full line of radiation instruments by RIDL, write to Dept. J for Catalog 61.

RIDL Radiation Instrument Development Laboratory, Inc.
61 EAST NORTH AVE. • NORTHLAKE, ILLINOIS
PHONE: MUrray 1-2323 • Cable Address: RADILAB

the functional approach essential and prerequisite to understanding of any structure but that any scientist who does more than fill catalogs full of numbers uses the functional approach all the time, willy-nilly. He does so because that is one of the functions which human beings are built to carry out.

WILLIAM T. POWERS
4024 Bluebird,
Rolling Meadows, Illinois

William Powers states a viewpoint which we support and have done much to document. Our only regret is that he should have misinterpreted the statements made in our original communication and have attributed to us a position which we deprecate. Far from implying that the differences in "normal" and "anxious" subjects "must be due to brain damage of some sort," as Powers deduced, we stressed that "studies of the microscopic structure of the nervous system have revealed no significant changes in the brains of persons suffering from the common neuroses and psychoses." The remainder of our communication presented evidence that one might be able to measure electrographically dysfunction in this group of chronically anxious subjects who have no known demonstrable damage to structure. Although Powers purports to find us hinting that structural damage is the cause of neurosis or psychoses, there is no such statement or suggestion anywhere mentioned or implied; nor indeed do we subscribe to such a view.

Our brief report concerned one electrographic method which might be used to evaluate brain function or dysfunction, regardless of the basis of the impairment. We would reaffirm our original statement that "perhaps more sensitive methods of measuring responsiveness in the electroencephalogram may demonstrate other evidence of impairment [of function] in the 'functional' disorders of the brain."

CHARLES E. WELLS
HAROLD G. WOLFF
New York Hospital—Cornell,
Medical Center, New York, New York

Conversions

Pembroke J. Hart in his letter on conversions [*Science* **132**, 256 (22 July 1960)] uses a conversion factor of 1.1516 statute miles per nautical mile. This is the factor given in most current reference works, yet since 1 July 1954 the Department of Commerce and the Department of Defense have been using the international nautical mile, defined as exactly 1852 meters, for which the conversion factor is 1.1508 statute miles per nautical mile.

Prior to 1 July 1954 the United States used a nautical mile of 6080.20 feet (1853.248 meters). The international nautical mile at the time of its adoption by the United States was equivalent to 6076.1033 U.S. feet, but effective 1 July 1959 the United States adopted the international yard, equivalent to 0.9144 meter. Therefore the international nautical mile is now equivalent to 6076.11549 international feet.

It is apparent that the term *nautical mile* is ambiguous and, when encountered in a scientific paper, is difficult to interpret. As Hart points out, conversions in the metric system are much simpler.

I suggest that the use of *nautical mile* be restricted to air and surface navigation, where it has real value, and that metric distance units be used in space flight and rocketry.

WILLIAM H. ALLEN
5223 MacArthur Boulevard, N.W.,
Washington, D.C.

Pembroke J. Hart, in his letter on conversions, evidently used for his conversion the "old" nautical mile, which for the United States was 6080.20 feet and for the British, 6080.0 feet. The former would give his ratio of 1.1516 (1.15155).

The "new" nautical mile or international nautical mile, as defined by the International Hydrographic Bureau, was adopted by the United States on 1 July 1954; this length is 6076.1033 feet (*1*), and the ratio is 1.1507575.

H. ROBERT DURSCH
Skagit Valley College,
Mount Vernon, Washington

Reference

1. N. Bowditch, *New American Practical Navigator*, (Government Printing Office, new ed. Washington, D.C., 1958), p. 65 (*U.S. Navy Hydrographic Office Publ. No.* 9).

P. J. Hart's letter complaining about two instances of imprecise conversions from metric to English units is meant to point up one of the advantages of converting to the metric (decimal) system universally. I wish to use it for a different lesson. We should rid ourselves of the pedants who translate a news item about a 4540-kilogram spaceship into 10,009 pounds, as well as the squares who round off the conversion factor and come out with 9988 pounds. I don't have access to the original report but suppose that it came out of the U.S.S.R. as a news item, not as a scientific datum. The aim was to command admiration, not to provide a basis for computing the burning time of the rocket motor. Rendered into English (U.S.), the weight of the satellite, as a news item, is 5 tons.

Now for the generalizations: (i) "If you wish to have what you say remembered, put it in the words that your

BETHLEHEM POLARISCOPE

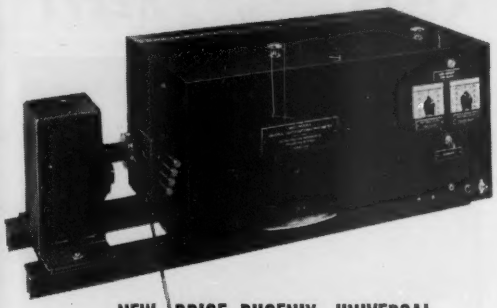
for showing strains in glass or plastic

* **FULL COLOR** . . . for high sensitivity and clarity.
* **A DUAL PURPOSE UNIT** . . . excellent for BENCH inspections . . . and light and convenient for PORTABLE USE.

Model P5 BETHLEHEM POLARISCOPE
* Adjustable Arms
* 110 v. Light Source
* Switch in Cord
* Constructed of Aluminum and Steel
* Finished in Baked Hammertone Grey
* Net Weight . . . 1-¾ lb.
* Price . . . $65.00

BETHLEHEM APPARATUS COMPANY, INC.
HELLERTOWN, PA.

MEASURE MOLECULAR WEIGHT AND PARTICLE SIZE



NEW BRICE-PHOENIX UNIVERSAL LIGHT SCATTERING PHOTOMETER

Measures:

1. Absolute Turbidity
2. Dissymmetry
3. Depolarization

This instrument is listed in U.S. Government specifications for the evaluation of certain clinical materials.

PHOENIX PRECISION INSTRUMENT COMPANY
3805 N. 5th St. Philadelphia 40, Pa.

BRONWILL OFFERS NEW UNITA

INFUSION APPARATUS

24 INFUSION RATES
from 0.125 μl/min.
to 5 ml/min.
5 or 50 ml syringes.

For infusion of small liquid volumes at a controlled, accurately reproducible rate. Selected rates are shown in an indicating window, both in μl/min, ml/min; and in μl/hr, ml/hr. Infusion rates are selected by turning a knurled knob.

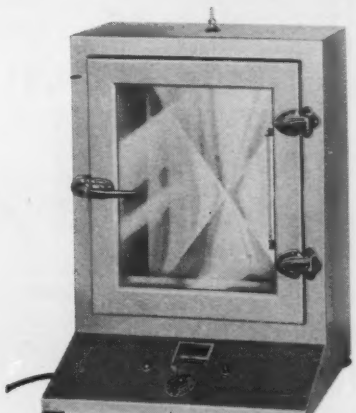
WRITE FOR NEW DETAILED LITERATURE

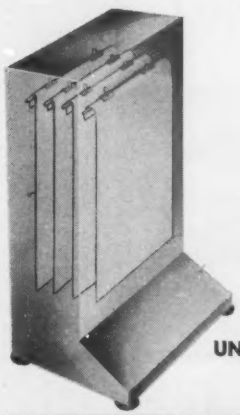
ALSO AVAILABLE: Unita II for continuous infusion over unlimited periods of time; Unita IIa from 0.008 to 5.000 ml/hr, Unita IIb from 0.45 to 300 ml/hr.

BRONWILL SCIENTIFIC
A Division of Will Corporation
3907 Russell Street • Box 3927, Rochester 10, N. Y.

BENCH-TOP

CHROMOTOGRAPHY DRYING OVEN ~ ~ ~ $360





Holds Four 18¼" x 22½" Sheets.
Provides Full View of Color Development.
Assures Fast, Uniform Drying Action.

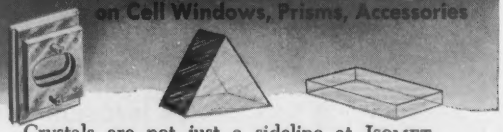
Develop 4 Chromatograms simultaneously in this compact drying oven. It is fully insulated and thermostatically controlled to quickly reach pre-set temperatures up to 110° C. Uniform drying action is assured by the continuous circulation of air from room. Air and solvent vapors are efficiently evacuated by connecting the oven to a water or motor aspirator. The heating element is concealed in the base and protected from droplets of combustible solvent. Safety glass readily permits temperature reading, and observation of color development without repeated opening of the heavy, metal-reinforced door. The stainless steel oven is corrosion resistant.

OVERALL DIMENSIONS:
26" Wide x 35" High x 15" Deep.
UNCONDITIONAL ONE YEAR WARRANTY

WRITE FOR CATALOG CO-023S

NEW BRUNSWICK SCIENTIFIC CO., INC.
PRECISION LABORATORY APPARATUS
P.O. BOX 606, NEW BRUNSWICK, NEW JERSEY

INFRARED
Spectroscopists
Dependable, Prompt Delivery
on Cell Windows, Prisms, Accessories



Crystals are not just a sideline at ISOMET. Years of research and development have enabled us to produce consistently the highest quality crystals obtainable and at attractive prices. We go all out to serve you with

HIGHEST QUALITY
ATTRACTIVE PRICES • PROMPT DELIVERY

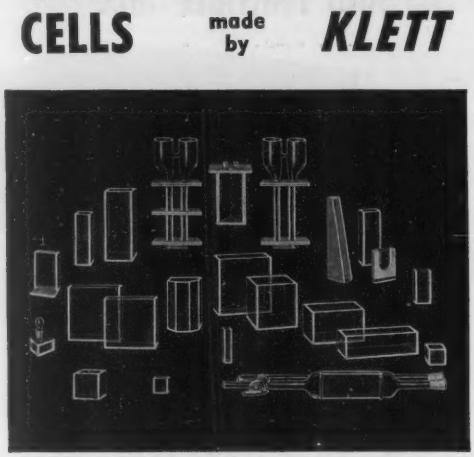
—three good reasons why leading spectroscopists everywhere are turning to ISOMET for their crystal needs. Why don't you try us on your next order.

NaCl, KBr, KCl, KI, CsBr, CsI, BaF_2, MgO
Rough blanks, polished windows, prisms, special shapes;
Standard liquid and gas cells; special cells.
Repair and polishing service for cells and windows;
KBr Pellet Powder.

WRITE TODAY for price list and free Technical Bulletin No. 1577.

Isomet
CORPORATION
P.O. Box 34—Palisades Park, N. J.

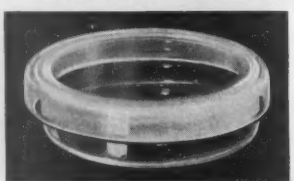
GLASS ABSORPTION CELLS made by ***KLETT***



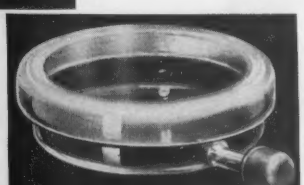
SCIENTIFIC APPARATUS
Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.
179 East 87 Street, New York, New York

improved **Sealable Type**
TISSUE CULTURE DISHES
. . . by *Bellco*



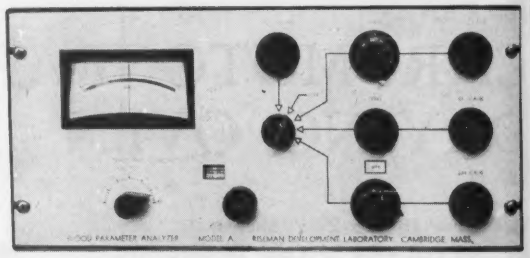
AVAILABLE IN
30 mm., 40 mm.,
50 mm., 65 mm.
SIZES



MADE FROM
PYREX BRAND GLASS

WRITE TODAY FOR
DESCRIPTIVE LITERATURE
AND PRICES.

BELLCO GLASS INC.
DEPT. 54 — VINELAND, NEW JERSEY



RAPID & ACCURATE **pH pCO_2 pO_2**
IN WHOLE BLOOD AND OTHER BIOLOGICAL SAMPLES

The Blood Parameter Analyzer Model A is basically an ultra-stable null-type pH meter with additional measuring circuits to read out CO_2 and O_2 electrodes. As a pH meter, it is sensitive and readable to 0.001 pH. pCO_2 and pO_2 are read directly in mm of Hg. Calibration controls are provided with locks and arranged in convenient function groups around the selector switch.

This instrument is especially useful where determinations must be made quickly, or where a large number of successive samples must be run.

All three determinations can be performed on a sample of whole blood in about three minutes, with accuracy comparable or better than that of conventional techniques. Details on request.

RISEMAN DEVELOPMENT LABORATORY
18 MOUNT AUBURN STREET CAMBRIDGE 38, MASS.

hearer will remember it in." (ii) Greater precision is not warranted in the statement than is available in the data.

Hart missed the opportunity to be an exemplary pedant; instead of arriving at 10,009 pounds from the handbook table he could have used the precise conversion factor and come up with 10,008.98542814 pounds.

R. R. NEWELL
50 Yerba Buena Avenue,
San Francisco, California

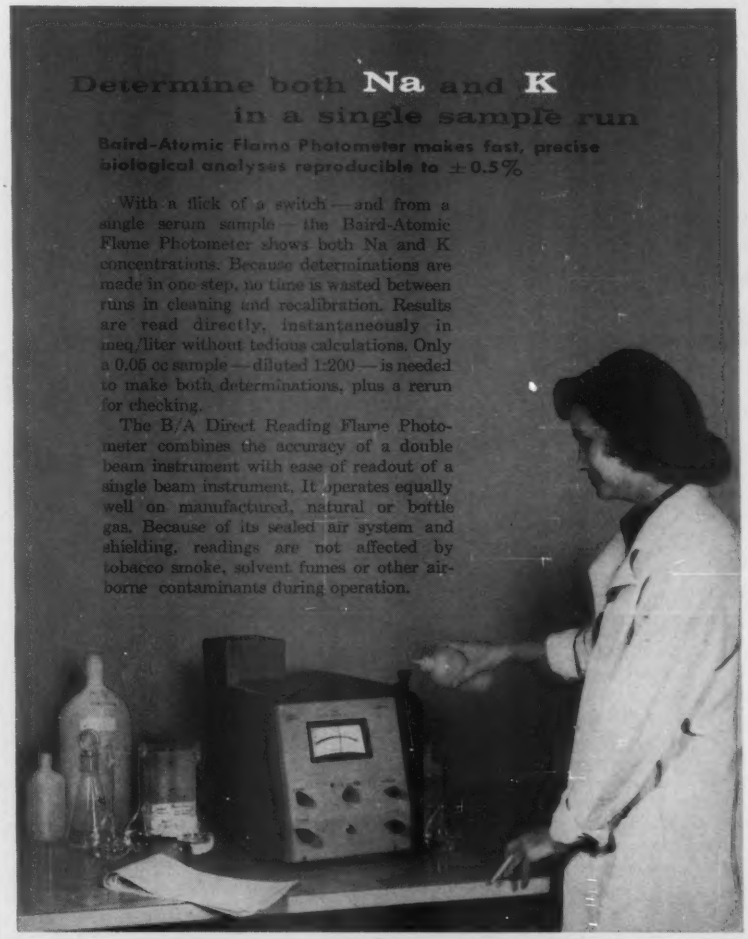
Humane Treatment of Animals

The bill S. 3570 recently introduced into the Senate by Senator Cooper and others, "To provide for the humane treatment of animals . . .," has been strongly attacked both in *Science* [**132**, 7 (1960)] and in the *Bulletin of the National Society for Medical Research.* These attacks have given what I think to be a false idea of the nature and intent of the bill, and of the motives of its sponsors, and prompt me to make a carefully considered statement of my own opinion.

The issue of humane treatment itself is a moral one: To what extent are we justified in inflicting pain and discomfort on other organisms in our search for knowledge? Bill S. 3570 takes the position "that living vertebrate animals used for scientific experiments shall be spared unnecessary pain and fear; that they shall be used only when no other feasible and satisfactory methods can be used to ascertain biological and scientific information for the cure of disease, alleviation of suffering, prolongation of life, or for military requirements; and that all such animals shall be comfortably housed, well fed, and humanely handled." This is a statement with which, I think, most biologists would agree in principle; personally I should feel more comfortable if the words *potentially valuable* were inserted after the words *scientific information,* but I think that the efforts of the National Society for Medical Research, the Animal Care Panel, and the American Physiological Society over the past several years have been directed toward the general aims stated above.

The second issue posed by the bill is a practical political one: Granted that humane treatment is desirable, is legislation, and in particular this legislation, the best means to assure it? The alternatives would seem to be voluntary action by the investigators or local control by individual communities. The charges recently brought against Stanford University and the College of Medical Evangelists in California show that local action under the influence of extremist pressure groups may still endanger medical research; it seems probable that the existence of federal legislation of the type proposed in S. 3570 would do much to protect laboratories against this sort of local attack. The question of voluntary action is a more debatable one. In my own experience I have never come across an instance of wanton cruelty to experimental animals, but I have encountered numerous cases of neglect due to callousness, inadequate facilities, inexperience, or carelessness; again, it would seem that S. 3570 would help to eliminate such instances.

The reasonable objections which have been made to the specific provisions of S. 3570 are well summarized in the *Science* editorial: "Advance approval of experimental plans by the Department of Health, Education, and Welfare, burdensome record keeping, annual or more frequent reports to HEW, additional costs . . . and a new and unnecessary amount of red tape." As I read the bill, it seems to me that the requirements are not greatly beyond those now in force. Every application for federal research funds requires submission of an experimental plan which is approved by a panel of scientists. I hope that all of us who publish results of animal experiments do at least the amount of record keeping specified by the bill. Every federal research grant now requires an annual report. The only additional features are that the experimental plan must specify what animals are to be used and what


Determine both Na and K
in a single sample run
Baird-Atomic Flame Photometer makes fast, precise biological analyses reproducible to ±0.5%
With a flick of a switch — and from a single serum sample — the Baird-Atomic Flame Photometer shows both Na and K concentrations. Because determinations are made in one step, no time is wasted between runs in cleaning and recalibration. Results are read directly, instantaneously in meq/liter without tedious calculations. Only a 0.05 cc sample — diluted 1:200 — is needed to make both determinations, plus a rerun for checking.
The B/A Direct Reading Flame Photometer combines the accuracy of a double beam instrument with ease of readout of a single beam instrument. It operates equally well on manufactured, natural or bottle gas. Because of its sealed air system and shielding, readings are not affected by tobacco smoke, solvent fumes or other airborne contaminants during operation.

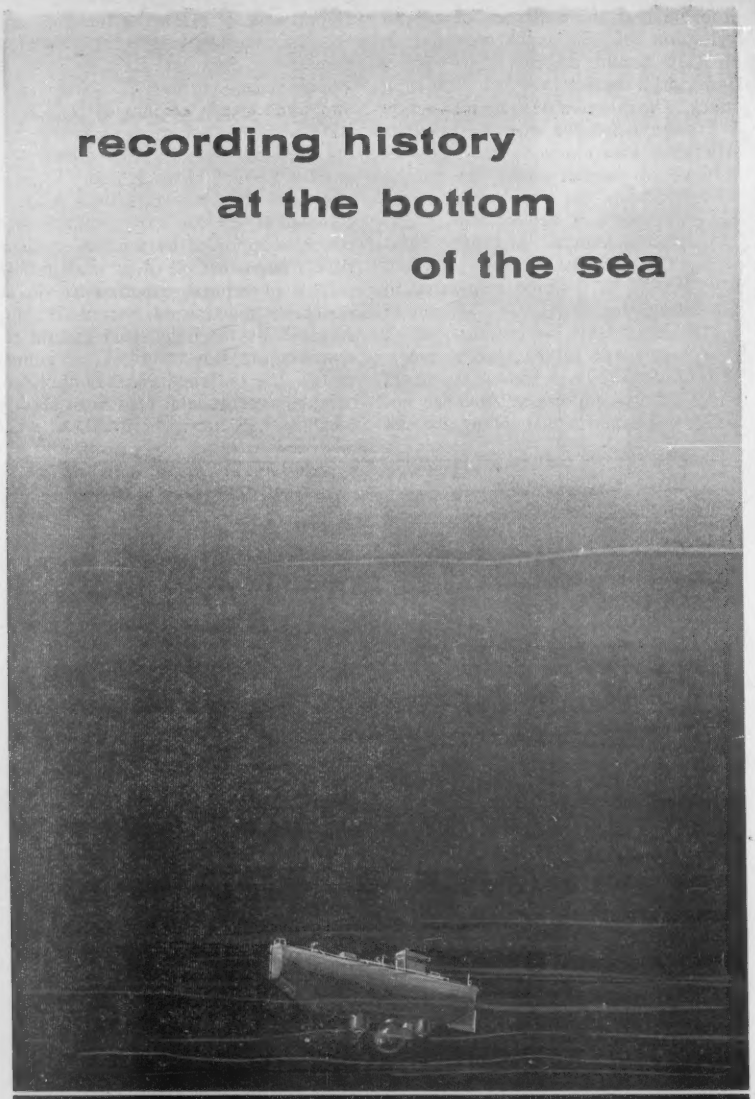
Write today for more complete information.

B/A Flame Photometer Condensed Specifications. Metals Analyzed and Guaranteed Sensitivity (1% of full scale):

Metal	meq/l	mg%	ppm
Na	0.001	0.002	0.02
K	0.0025	0.001	0.01
Li	0.028	0.02	0.02

Reproducibility: ±0.5% av. Size: 15" x 17" x 16" Wgt.: 35 lbs.

BAIRD-ATOMIC, INC.
33 university road · cambridge 38, mass.



Far below the surface, in a sealed steel ball on the *Trieste* bathyscaph, a new chapter in undersea history is being recorded—on magnetic tape. Operating in an environment of 99% relative humidity, a high-performance instrumentation tape recorder captures a permanent record of depth, temperature, ambient noise, and voice.

The recorder, Precision Model PS-207 as shown at right, was modified for the application by Lockheed Aircraft Corporation, Sunnyvale, Calif., and supplied by them to the Naval Electronics Laboratory, San Diego, for the *Trieste* installation.

For details on Precision PS-200 series analog and digital recorders for other applications, write:

PRECISION INSTRUMENT COMPANY
1011 Commercial Street • LYtell 1-4441 • San Carlos, California
Cable: PRINCO, San Carlos, California • TWX: SCAR BEL 30

Representatives in principal cities throughout the world

type of experiments are to be performed; there is nothing in the bill requiring advance approval of every minor change in experimental procedure. The report, also, must specify the animals used and the procedures employed, but there is nothing in the bill to say that this must coincide exactly with the plan proposed. Compliance with the provisions of the bill will cost more, insofar as the existing laboratories do not provide adequate facilities for the animals used, but this should result in better experimental results as well as more humane care.

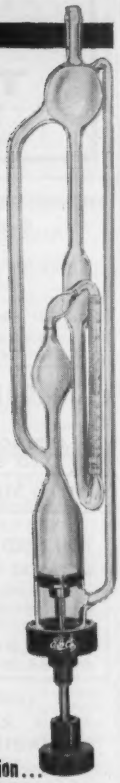
The National Society for Medical Research has devoted much attention to the provision for inspection of facilities and for certificates of compliance with regulations to be laid down by the Secretary of Health, Education, and Welfare; this is presumably the red tape with which *Science* is concerned. At present, every institution receiving grants from federal agencies is visited—or if you wish, inspected—by officers of those agencies. On the basis of past experience, I think that we have nothing to fear from these officers, who have abundantly demonstrated that their main aim is to further research of the highest quality. Any regulations which HEW might lay down under an act of the sort proposed would, I think, not depart from this aim. In any event, the bill gives no police powers to HEW or anyone else, so that work sponsored by any but federal agencies would not be in any way affected.

In sum, I cannot find in this bill the evils which the National Society for Medical Research or *Science* profess to see, and I would urge my colleagues who are interested in animal experimentation, humane treatment, or both, to read the bill with care, to make their own appraisals on the basis of their own judgments, and to communicate these judgments to their representatives in the Congress.

BRADLEY T. SCHEER
College of Liberal Arts,
University of Oregon, Eugene

I read with considerable interest your article on the Cooper bill, S. 3570 [*Science* **131**, 1659 (1960)]. It seems a holy and ennobling thought that our animal friends should be generously accorded some measure of protection from our mighty and benevolent government. Your article, however, referred simply to experimental "animals"; I should hope that the sponsors of this bill were more explicit in their definition of the organisms to be protected. Do they include viviparous mammals only? mammals only? warm-blooded vertebrates only? vertebrates only? chordates only? vertebrates and invertebrates, including protista and bacteria? vertebrates and invertebrates,

SIMPLIFIED NEW OPEN END McLEOD GAUGE



adjusts micrometrically for fastest, easiest, most accurate readings!...

on two scales— 0-10mm. and 1-1000 micron

Eliminates Capillary Contamination... Compresses Gas Between Two Mercury Columns

This advanced new Open End McLeod Gauge simplifies the former 2-tube system with one direct reading manometer. Obvious points of superiority: no more closed end capillary to become contaminated; no comparison capillary to complicate matters; no chance of compounding error in 2 measurements. Micrometer adjustment of the mercury meniscus is made possible by a rubber "O" ring vacuum sealed piston operating in precision bore tube—permitting more precise readings, faster than ever!

T10710 VACUUM GAUGE, OPEN END McLEOD TYPE, complete and ready for use but without mercury. 69.50

The EMIL GREINER *Co.*

59-16 N. Moore St. Dept. 427, N. Y. 13, N. Y.

including all protista and bacteria which are not primarily or facultatively photosynthetic? Surely our senators will not endorse the statements of a mammologist acquaintance of mine: "If it isn't warm, it's dead," or, in his more extreme moments, "If it doesn't have red blood, it's a plant."

In a democratic society, it does not seem an unreasonable analogy to suggest that all organisms (or at least nonphotosynthetic and/or nonparasitic organisms, though such exceptions might hint of an occupational elite) are created equal. If the criterion for inclusion under the bill is to be a phylogenetic one, it would seem somewhat arbitrary to propose protection up to and including tenth cousins, three times removed, and imply that tenth cousins, four times removed, are beyond the pale, and that eleventh cousins are of course unworthy.

I am confident that herpetologists and ichthyologists, entomologists and protozoologists would strongly protest any regulation which would not afford the full measure of governmental safeguards to the organisms of their interest. Such a slight would imply that these animals are, because of their immediate ancestry, unworthy of the full concern and protection of the government. I myself would emphatically oppose any such derogatory implication about the crustacea, which are my current interest. Such prejudgment, based on uncontrollable accidents of birth and ancestry, seems contrary to the American spirit of recognition of individual abilities and character.

As a further extension of this bill, it seems wholly logical that if a housewife (whose husband is at least partially dependent on federal money) plans to trap an intruding mouse (*Mus musculus*), her premises and the proposed trapping device should be inspected and certified for compliance, and that she be then licensed as an authorized animal experimenter. Then, of course, the Secretary of Animal Health, Education, and Welfare would have to review the proposal in detail. Likewise, any insecticide should receive the seal of approval from the SPCA—or its governmental equivalent—as the certified, least painful means of attaining the desired goal. Undoubtedly, properly motivated congressmen will see the myriad other logical, and thus necessary, extensions of the Cooper bill: animal husbandry, commercial fisheries, hunting and fishing as sports, to mention only a few of the more obvious.

J. T. ENRIGHT

3256 Luna Avenue,
San Diego, California

The Cooper bill (S. 3570) is concerned with "live vertebrate animals used for scientific experiments."—Ed.

TECHNICON

AUTOMATIC VARIABLE GRADIENT DEVICE*

produces any buffer requirement in *pH* or concentration for chromatography

Eliminates **DISCRETE BUFFER CHANGEOVERS**

as an example . . .

to pH 5.28

to pH 4.25

from pH 3.25 *. . . usual in*

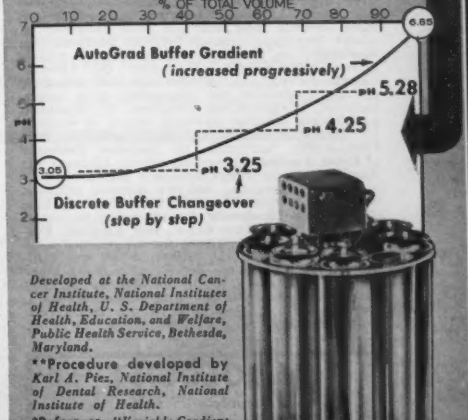
AMINO ACID CHROMATOGRAPHY

*instead the Autograd automatically supplies a buffer gradient in a continuous, uninterrupted flow.***

† Trademark

Produces higher Resolution

The Autograd† starts the column elution delivery at *pH* 3.05, as shown above, and progressively in a continuous flow, increases to *pH* 6.85. Not only is each discrete buffer value systematically produced, but the resulting gradient includes *all* of the intermediate values as graphed below.



Developed at the National Cancer Institute, National Institutes of Health, U. S. Department of Health, Education, and Welfare, Public Health Service, Bethesda, Maryland.

***Procedure developed by *Karl A. Piez, National Institute of Dental Research, National Institute of Health.*

*Reference: "*Variable Gradient Device for Chromatography*", E. A. Peterson and H. A. Sober, Anal. Chem., Vol. 31, No. 34, May 1959.*

Send for Brochure No. AG1, and further Data, to:

Technicon Chromatography Corp.
Research Park · Chauncey, New York

PERSONNEL PLACEMENT

CLASSIFIED: Positions Wanted, 25¢ per word, minimum charge $4. Use of Box Number counts as 10 additional words. Payment in advance is required.

COPY for ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Positions Open. Rates listed below—no charge for Box Number. Rates net. No agency commission. No cash discount. Minimum ad: 1 inch. Ads over 1 inch will be billed to the nearest quarter inch. Frequency rate will apply to only repeat of same ad. No copy changes. Weekly invoices will be sent on a charge basis—provided that satisfactory credit is established.

Single insertion	**$40.00 per inch**
4 times in 1 year	**38.00 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

POSITIONS WANTED

(a) **Organic Chemistry** Ph.D., registered pharmacist; 8 years in research-development of drug products including multi-compressed tablets; available for research or technical directorship with pharmaceutical firm. (b) **Biology** Ph.D., chemistry minor; 4 years of biology teaching; 3 years of pharmacology research on carbohydrate metabolism studies; desires research or academic appointment. S9-4 Medical Bureau, Inc., Science Division, Burneice Larson, Chairman of the Board, 900 North Michigan Avenue, Chicago. X

POSITIONS OPEN

(a) **Bacteriologist;** B.S., M.S. to head busy department, supervise three technologists; 500-bed general hospital; minimum $6000; midwestern city 250,000. (b) **Chemist,** head new section on bioanalysis and control, southeastern state health department; responsibilities include consultation, evaluation, liaison; $6300. Science Division, Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

(a) **Professor-Chairman of Biological Chemistry Department** qualified for teaching, research, administrative duties at medical school; Midwest. (b) **Assistant Professor of Physiology** to teach and develop individual research program at medical school; Midwest. (c) **Nutritionist,** Ph.D. level to establish metabolic laboratory at university medical center; teaching opportunity if desired; to $10,000; Southwest. (d) **Semiretired Scientist** for part-time physiology/biochemistry research in new unit of large hospital; $7000–$9600; Pacific area. (e) **Pharmaceutical Chemistry Group Leader** with administrative skill and ability to organize new projects for product development for leading drug firm; $12,000–$13,000; East. (f) **Virologist** with tissue culture knowledge to head department of drug biological firm with extensive research program; around $10,000; Midwest. (g) **Biochemist** to direct new laboratory of pathologists; $8000–$10,000; Northwest (h) **Pharmacologist** for research on new chemicals and their activity evaluation for expanding drug manufacturer; $8000–$10,000; Midwest. (i) **Biochemist/Biologist** qualified in tissue culture or virology for cancer research at university medical center; $7000–$9000; Southwest. (j) **Assistant Professor of Gross Anatomy** at medical school; Midwest. (k) **Bacteriologist** to supervise section and participate in teaching program; 400-bed hospital affiliated with leading medical school; $8000–$11,000; East (l) **Research Biochemist** for expansing biological consulting firm; West Coast. (m) **Assistant Professor of Veterinary Science** for infectious disease research at agricultural college; $7000 up; Midwest. (Please write for details; also many other positions available through our nationwide service.) S9-4 Medical Bureau, Inc., Science Division, Burneice Larson, Chairman of the Board. 900 North Michigan Avenue, Chicago. X

VIROLOGIST
Preferably with M. S.
2 to 3 years experience.
Send résumé to:
EMPLOYMENT MANAGER
Lederle Laboratories Pearl River, New York

POSITIONS OPEN

CHEMIST

Experienced in drug analyses. Able to apply modern physical methods. Willing to work at bench and assume supervision of others. Long-established independent laboratory, central Philadelphia. State training and experience. Immediate opening, starting date may be as late as 1 November. Replies confidential until after personal interview.

Box 179, SCIENCE

Directorship Hematology and Blood Bank

Applicant should be at doctorate level. Heavy service load including cardiac surgery. Large research potential, university teaching and consultant appointments possible. Salary and privileges are not a limiting factor and will be commensurate with ability of applicant. Call or write Dr. C. J. Lind, Jr., Director of Laboratories, St. Luke's Episcopal Hospital, Texas Medical Center, Houston 25, Texas. X

Organic Chemist

Ph.D., for basic research in polyamino acids by government laboratory, Louisville, Kentucky, area. Position is in career federal civil service. Opportunity to head new branch. Excellent facilities. Academic affiliation with neighboring university. GS level and salary rate depending upon experience. Travel and transportation expenses paid by government.

Box 181, SCIENCE

The Market Place

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

BOOKS AND MAGAZINES

SCIENTIFIC JOURNALS WANTED

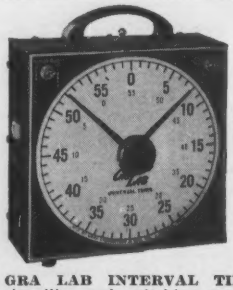
Sets, Runs and Volumes bought at top prices. Your wants supplied from our Back Files of over 3,000,000 periodicals. **Abrahams Magazine Service, N. Y. 3, N. Y.**

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

SUPPLIES AND EQUIPMENT

CAESAREAN-DERIVED
Mice
CHARLES RIVER CD-1
Hypophysectomies
THE CHARLES RIVER MOUSE FARMS
Affiliate, The Charles River Breeding Labs
1018 Beacon St., Brookline 46, Mass. RE 4-2000



ELECTRIC
LAB TIMER
Giant 8" Dial

GRA LAB INTERVAL TIMER Automatic signalling and switching over unusually wide range of 3600 possible settings.
GRA LAB MICRO TIMER 1/10 sec. or 1/1000 min. stop clock. Remote start stop control. Write for catalog.

DIMCO-GRAY COMPANY
214 E. SIXTH ST., DAYTON 2, OHIO

SUPPLIES AND EQUIPMENT

SWISS MICE

Send for booklet

TACONIC FARMS
GERMANTOWN NEW YORK

1919 - 1960
LaMotte Chemical
Chestertown, Maryland, U.S.A.
Specialists in
Colorimetric Techniques
Reagents-Standards-Comparators
Send for Illustrated
Controls Handbook Dept. H

Rats from the Wistar Strain
Guinea Pigs — Hamsters
Laboratory Animals
since 1929
ALBINO FARMS, P.O. BOX 331
RED BANK, NEW JERSEY
Swiss Mice — Albino Rabbits

YOU NEED THIS **FREE**
CATALOG FOR YOUR FILES

Serums, antiserums and bloods of all kinds for technicians and tissue culture laboratories. No salesman will call.
COLORADO SERUM CO.
4950 York St. • MAin 3-5373 • Denver 16, Colo.

LABORATORY RATS
RABBITS—MICE
HARTLEY GUINEA PIGS
other lab animals upon request
RESEARCH ANIMALS, INC.
3401 FIFTH AVE.
PITTSBURGH 13, PA.
Tele. MUseum 1-4156

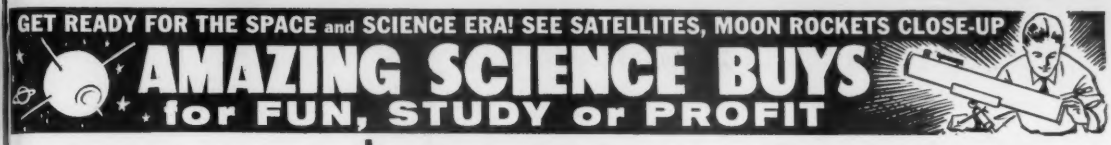
Now taking orders for:
C3H • AKR • STRONG A • C57BL
(C3H x 101) F1
TEXAS INBRED MICE CO.
305 Almeda-Genoa Rd.; R.F.D. 7, Box 1232-C
Houston 21, Texas

Laboratory Animals
Mice Rats **Hamsters** **Guinea Pigs Rabbits**
Information sent on request
H. S. HURLBURT
Animal Research Center, Bainbridge, N.Y.
WOrth 7-5415

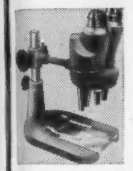
SWISS MICE
BACTERIOLOGICAL AND GROSS TISSUE STUDY TECHNIQUES USED IN OUR QUALITY CONTROL
HUNTINGDON FARMS, INC.
2548 NORTH 27th ST. PHILA. 32, PA.

GET READY FOR THE SPACE and SCIENCE ERA! SEE SATELLITES, MOON ROCKETS CLOSE-UP

AMAZING SCIENCE BUYS for FUN, STUDY or PROFIT



American Made — Terrific Buy!



Over [illegible] Saving
STEREO [illegible]CROSCOPE

Years in development. Precision American made. Used for checking, inspecting, small assembly work. Up to 2" working distance. Clear, sharp, erect image. Wide, 3 dimensional field. 2 sets of objectives on rotating turret, 23X and 40X. 10 Days Free Trial.

Stock No. 85,056-W ..... $99.50 f.o.b. Barrington, N.J.

Low Power Supplementary Lens Attachment for above Stereo—provides 15X down to 6X with clear, extra large 1½" field at 6X.

Stock No. 30,276-W $7.50

NEW! GRAPH RUBBER STAMP

Real time and labor saver for math teachers. If your tests require graph backgrounds—no need to attach separate sheets of graph paper and worry about keeping them straight. Simply stamp a graph pattern, 3" square as needed on each paper. Grading graph problems then become 100% easier. Stamps are 3" square overall—2 different patterns.

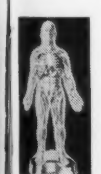
Stock No. 50,255-W (100 blocks) ..... $3.00 Postpaid
Stock No. 50,351-W (16 blocks) ..... $3.00 Postpaid
Polar Coordinate Graph Stamp—3" Diam.
Stock No. 50,359-W ..... $3.00 Postpaid

OFFSPRING OF SCIENCE . . . REALLY BEAUTIFUL! CIRCULAR DIFFRACTION-GRATING JEWELRY

Shimmering rainbows of gemlike color in jewelry of exquisite beauty—made with CIRCULAR DIFFRACTION-GRATING REPLICA. Just as a prism breaks up light into its full range of individual colors, so does the diffraction grating. Promises to become a rage in current fashion.

Stock No. 30,349-W Earrings ..... $2.75 Pstpd.
Stock No. 30,350-W Cuff Links ..... $2.75 Pstpd.
Stock No. 30,372-W Pendant ..... $2.75 Pstpd.
Stock No. 30,390-W Tie-Clasp ..... $2.75 Pstpd.

16" VISIBLE MAN KIT



Amazing! You look right through it! Reveals the wonders of the human body in exact scale, with all vital organs precisely detailed. Authentic laboratory models includes complete skeleton, skin, muscles, circulatory system. Ingenious parts-within-parts assembly permits examination of respiratory system, chambers of the heart, interior of kidneys, etc. Internal organs demountable for close inspection. Just 16" high when assembled, but compares favorably with expensive hand-made medical school models. Ideal for researchers, labs, doctors, teachers, students, hobbyists. Base and 12-page INTRODUCTION TO ANATOMY included.

Stock No. 70,228-W ..... $4.98 Postpaid

NEW BINOCULAR-TO-CAMERA HOLDER

Will Fit Any Camera

For Exciting Telephoto Pictures. Bring distant objects 7 times nearer with a 35mm camera, 7x50 binocular and our NEW BINOCULAR-TO-CAMERA HOLDER. Ideal for long-range shots of wild life, ships, people, vistas. Camera and binoculars attach easily. Use any binocular or monocular—any camera, still or movie. Take color or black and white. Attractive gray crinkle and bright chrome finish. 10" long. Full directions for taking telephotos included.

Stock No. 70,223-W ..... $11.50 Postpaid

Photographers! This is an actual photograph of the moon taken through our Astronomical Telescope by a 17-year student.

See the Stars, Moon, Planets Close Up!

3" ASTRONOMICAL REFLECTING TELESCOPE

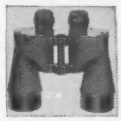
60 to 180 Power. An unusual Buy! Famous Mt. Palomar Type

You'll see the Rings of Saturn, the fascinating planet Mars, huge craters on the Moon, Star Clusters, Moons of Jupiter in detail. Galaxies! Equatorial mount with lock on both axes. Aluminized and over-coated 3" diameter high-speed f/10 mirror. Telescope comes equipped with a 60X eyepiece and a mounted Barlow Lens, giving you 60 to 180 power. An Optical Finder Telescope, always so essential, is also included. Sturdy, hardwood, portable tripod—**FREE with Scope:—Valuable STAR CHART plus 272 page "HANDBOOK OF HEAVENS" plus "HOW TO USE YOUR TELESCOPE" BOOK.**

Stock No. 85,050-W ..... $29.95 Postpaid

4¼" Reflecting Telescope—up to 255 Power, all-metal pedestal mount.
Stock No. 85,105-W ..... $79.50 F.O.B. Barrington, N.J.

War Surplus American-Made 7x50 Binoculars



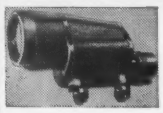
Big savings! Brand new! Crystal clear viewing—7 power. Every optical element is coated. An excellent night glass—the size recommended for satellite viewing. Individual eye focus. Exit pupil 7mm. Approx. field at 1,000 yds. is 376 ft. Carrying case included. American 7 x 50's normally cost $195. Our war surplus price saves you real money.

Stock No. 1533-W ..... Only $55.00 Postpd. (Tax included)

Terrific Buy! American Made! OPAQUE PROJECTOR

Projects illustrations up to 3" x 3½" and enlarges them. No film or negatives needed. Projects charts, diagrams, pictures, photos, lettering in full color or black-and-white. Operates on 115 volt, A.C. current. 6-ft. extension cord and plug included. Operates on 60 watt bulb, not included. Size 12" x 8" x 4½" wide. Weight 1 lb., 2 oz. Plastic case with built-in handle.

Stock No. 70,199-W ..... $7.95 Postpaid



Take Telephoto Shots Thru 7 x 50 MONOCULAR

This is fine quality, American made instrument—war surplus! Actually ½ of U.S. Govt. 7 x 50 Binocular. Used for general observation both day and night and to take fascinating telephoto shots with your camera. Brand new, $95 value. Due to Japanese competition we close these out at a bargain price. Directions and mounting hints included.

Stock No. 50,003-W ..... $15.00 Postpaid

LIFE SIZE HUMAN SKULL

Invaluable educational aid! Fascinating conversation piece! Skull is anatomically correct—made of natural bone color, bone hard, lifetime plastic. Parts snap together—take apart. Spring-action lower jaw. Removable skull cap for examination of skull cavity, nasal passages, etc. Ideal for scientists, doctors, dentists, teachers, students, artists. Stand and Instruction and Anatomy Chart included.

Stock No. 70,294-W ..... $4.95 Postpaid

SCIENTIFIC ENCYCLOPEDIA

Over 1800 pages! 1400 illustrations—over 2,000,000 words—100,000 definitions—14,000 separate articles. If you're science-minded—you'll drool over it! Wealth of useful information on Science, Math, Engineering, Chemistry, Physics, etc. 8½ lbs—size 9" x 11".

Stock No. 9287-W ..... $29.75 Postpaid

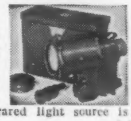
GIANT OPTICAL BARGAIN KIT

Useful popular items all in one package. You get: PRISM; DIFFRACTION GRATING; POLARIZING FILTERS; 5 LENSES DOUBLE-CONVEX, 14 x 48mm; "FUN WITH OPTICS", 32-page instruction book; "BEGINNER'S LENS KIT", 10 lenses to make many optical items; "STAR & SATELLITE PATHFINDER" Instruction Book; RECTANGULAR MAGNIFIER. An excellent value.

Stock No. 50,204-W ..... $3.00 Postpaid

WAR SURPLUS!—INFRARED SNOOPERSCOPE

Govt. Cost $300—Bargain at $39.50



Converts infrared to visible light. See in total darkness without being seen. Use in lab, factory, classroom, etc. Completely portable. Operates on two flashlight batteries (not included). Image is quite good, may be made even better by careful focusing. Size 11½" x 8". Weight with carrying case 12 lbs. No infrared light source is furnished. (See below).

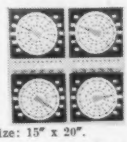
Stock No. 85,098-W ..... $39.50 f.o.b. Barrington, N. J.

INFRARED LIGHT SOURCE AVAILABILITY!

Uses 6-volt transformer or 6 V auto battery to operate.

Stock No. 80,035-W ..... $10.00 Postpaid

NEW! BRAINIAC COMPUTER SET



A fascinating and interesting introduction to the important new field of the computer. Makes such devices as: interplanetary time and space calculator, reasoning machine, logic games, intelligence tester, many other experimental units. All connections are with nuts and bolts—no soldering necessary. Designs can be changed in minutes. Complete with 23-page Booklet—plus 9 electrical research experiments. Overall size: 15" x 20".

Stock No. 70,305-W ..... $11.95 Postpaid

EXECUTIVE LEVEL ADULT GAMES

Fascinating fun. Teach you logic—to think and reason. MANAGEMENT, game of business practice, duplicates problems and practices of corporation management. GETTYSBURG, the fight-it-yourself war game, lets you re-fight the famous Civil War battle of Gettysburg (and the South can win)! TACTICS II, the military strategy game, develops your tactical skill, initiative, and military logic in realistic combat situations. All games are complete with playing boards or maps, instruction books, and all necessary accessories.

MANAGEMENT—Stock No. 70,287-W ..... $4.95 Postpaid
GETTYSBURG—Stock No. 70,284-W ..... 4.95 Postpaid
TACTICS II—Stock No. 70,286-W ..... 4.95 Postpaid

FREE CATALOG!

Optics for the Science Class! Optics for the Space Era!

128 PAGES! OVER 1000 OPTICAL BUYS!

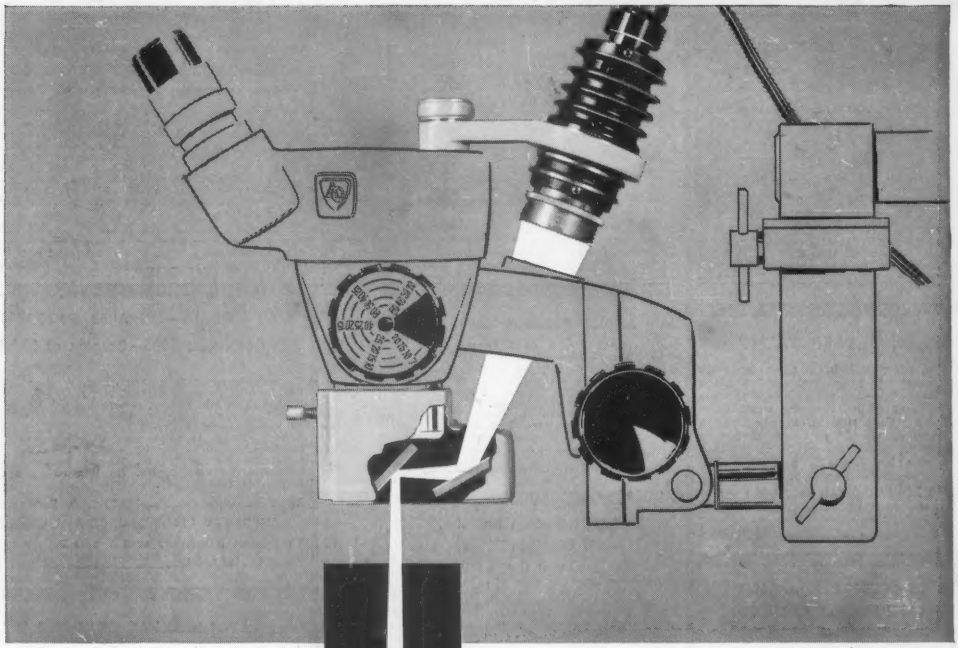
Huge selection of lenses, prisms, war surplus optical instruments, parts and accessories. Telescopes, microscopes, binoculars, infrared sniperscope, etc. Low-cost Science and Math Learning and Teaching aids.

Request Catalog W.

Easy Payment Plan Available! Details with Catalog!

ORDER BY STOCK NUMBER . SEND CHECK OR MONEY ORDER . SATISFACTION GUARANTEED!

EDMUND SCIENTIFIC CO., BARRINGTON, NEW JERSEY



SEE ALL THE WAY DOWN...

NEW, AO Spencer Vertical Illuminator allows stereoscopic magnification deep inside small diameter openings

The new Vertical Illuminator and the AO Spencer Cycloptic Stereoscopic Microscope make a unique team that can be the answer to your problem whether it's the inspection of detail in small diameter, deep hole borings, or delicate assembly of miniaturized parts where every move is critical.

This low-cost illuminator readily attaches to the Cycloptic to provide efficient, shadowless illumination deep inside small orifices... and the Cycloptic delivers realistic, erect, true three-dimensional magnification of the illuminated detail.

The remarkable long working distance afforded by Cycloptic (up to 7 inches when Illuminator is used with 53 and 59 Series) gives you *plus* advantages... permits ample room for large objects or inspection and assembly tools.

Add this unit to your present Cycloptic or ask about low-cost Vertical Illuminator and Cycloptic stereoscopic microscope combinations.

American Optical Company

SPENCER

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. J-4

Please send me FULL INFORMATION on the NEW AO SPENCER VERTICAL ILLUMINATOR AND CYCLOPTIC MICROSCOPES.

NAME_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____